THE
ELECTRICAL REVIEW.

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"ELECTRICAL REVIEW."

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THE
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THE CABINET CHANGES.

MR. CHAMBERLAIN'S scheme has been considered by the country as fully as such an incomplete plan well could be, with a result which has satisfied him that the country is not yet ripe for it. It is to be regretted that he attributes this result to inaccurate representations of the opposite party, since his proposals have aroused opposition altogether free from party considerations. Whatever the cause, Mr. Chamberlain retires, and will now occupy a position of freedom from which he can try to educate the country over to his views. But he does not enjoy this freedom alone. The Chancellor of the Exchequer and others retire also, but not with the object of assisting Mr. Chamberlain as pupil teachers. They will be free to expound their own views in opposition to those of the late Colonial Secretary, and their retirement is ostensibly due to their disagreement both with Mr. Chamberlain's scheme and with Mr. Balfour's modification of it. Mr. Chamberlain is the exponent of the new diplomacy; Mr. Balfour revives an old political method by putting his views before the public in pamphlet form. Briefly stated, the conclusion at which he arrives is this: we need some form of Protection for the purposes of negotiation.

Political unrest is not conducive to commercial activity, and to the manufacturing and trading interests of the country an important consideration will be the period and nature of this unrest. The influences seem to us to be of a more encouraging nature than was the case a few weeks ago. The danger which existed was that the strong man of the Government had taken a head-strong line, and with few exceptions it was not known how far he could carry his colleagues with him. The danger of revolutionary action by a Conservative Government has been averted, and the departure from the constitutional practice of the collective action of ministers has been avenged. There is some safeguard in the return to regularity in the methods of the administration.

We are not able to agree with those who aver that the correspondence between Mr. Balfour and Mr. Chamberlain indicates a complete identity of views, and that the programme to be followed is for Mr. Balfour to hold the fort whilst Mr. Chamberlain fights the battle, the intention being that the aims of Mr. Chamberlain shall be the eventual goal of the party. If this were so, the blow to business in the immediate future might be serious; but we take a more encouraging view, and believe that the course of events will be more reasonable and less exciting than seemed possible.

Mr. Chamberlain committed himself to a very extreme plan, though he purposely refrained from elaborating its details. Mr. Balfour took the matter into consideration and has committed to print, for general circulation, the foundations of his belief in much the same way as he might write on the philosophy of doubt. He believes that there is need for retaliatory duties for purposes of negotiation,

but he does not define either the duties or the methods of putting them in force. It will be time enough to deal with his proposals when their nature and effect can be accurately gauged, and when they are defined and placed as a plank in the Government platform.

At any rate, Mr. Balfour approaches the subject broadly and with an inquiring mind. It will take some time to evolve the practical measures, even if they are found to be practicable at all. A five-pound note is an excellent article to negotiate, because there is gold at the Bank; if there were not gold at the back of it the printed paper would not be a good subject to negotiate with, and retaliatory duties may conceivably offer only a paper negotiability.

The whole subject, however, is one which will take time to settle, and should only be considered carefully and thoroughly. Mr. Chamberlain brought it forward suddenly, and there was danger of political excitement which would disorganise business. Mr. Balfour treats it philosophically, the electors will probably do likewise; and it may be anticipated that business will resume its normal course. We see no occasion whatever for a suspension of that enterprise which might be normally expected, and which, for the best interests of electrical industry, is so essential.

RADIUM AT THE BRITISH ASSOCIATION.

The interesting discussion on radium at the British Association developed into an attempt to determine whether radio-active substances derive their energy from an external source, or from the liberation of energy stored up in the atom. In a paper contributed by Lord Kelvin the former view was upheld. Radium was compared to a piece of black cloth enclosed in a glass tube immersed in water and exposed to sunlight. Such a piece of cloth would absorb more heat from the sun's rays than a piece of white cloth in the same position, and would therefore maintain the surrounding water at a slightly higher temperature in the former case than in the latter. The form in which the external energy reached the radium was not specified, but he suggested that interesting results might be obtained by surrounding the radium by different kinds of screens, and determining whether the amount of the radiation was thereby affected. Prof. Dewar explained an experiment which he had carried out for M. Curie, and which appeared to correspond with that suggested by Lord Kelvin. Liquid hydrogen was placed in a bottle with double sides coated with silver or mercury, and enclosing a vacuum, an arrangement which has been shown to be a practically perfect screen for preventing the passage of heat either by conduction or radiation. To still further increase the insulating properties of this bottle it was immersed in liquid air. Under ordinary conditions there was no evolution of hydrogen gas from the liquid in the bottle, but when a particle of radium was dropped into the liquid there was a continuous evolution of hydrogen gas. This gas when collected and measured gave a measure of the radio-active energy of the radium. The energy emitted by the radium appeared to be rather greater at the temperature of liquid hydrogen than at higher temperatures.

These experiments of Prof. Dewar give great support to the theory of Rutherford and Soddy, that the energy of radium is derived from energy stored up in the atom. Sir Oliver Lodge gave a provisional support to this theory, and pointed out that the instability of the atom had already been foreshadowed in the theoretical work of Larmor, who had shown that atoms ought to be unstable because they were continually radiating energy into space. Prof. Schuster said he always looked with suspicion on statements as to the theoretical foreshadowing of novel experimental discoveries. In his opinion, the complicated phenomena observed by Rutherford and Soddy had not yet been accounted for by any theoretical system of electrical attractions and repulsions.

Prof. Schuster considered that all substances were probably radio-active to an extent which, though not measurable on small masses, might be very considerable on large aggregates. The known radio-active bodies would in that case be distinguished from other bodies—like iron in the case of magnetism—by the enormously exaggerated form in which they possessed the property. The earth was charged with negative electricity. But this charge must be continually leaking away, for Elster and Geitel had recently shown that the normal conductivity of the air was such that a body lost 1½ per cent. of its charge per minute. If the air in the immediate neighbourhood of the ground had this conductivity, the earth would lose half its charge in about an hour. The discharge of this large amount of negative electricity through the atmosphere pointed to the existence of radio-active substances on the earth's surface. The radio-activity of air arising out of the ground, or of water drawn out of wells, might be due to emanations produced by the terrestrial radiation of electrons.

Prof. Larmor stated that most physicists were agreed in seeing an explanation of radio-active phenomena in an electric theory. The divergence arose on questions of detail. Everything depended on the dimensions and configurations of the electrons. Hitherto they had been looked upon as points, but if they were of definite size they were capable of explaining all the properties of the molecule. The experiments of Prof. Dewar had shown that radium could excite, in surrounding nitrogen, a bright line spectrum. This pointed to violent chemical disruption of a much more severe character than the collisions assumed in the kinetic theory of gases. He favoured Prof. Rutherford's theory as to the origin of the kinetic energy of radium, &c., his supposition being that it existed within the atom in the form of rotational motion.

The Influence of Spectrum Analysis on Chemistry.

As indicated by the title we have given it, the presidential address delivered by Prof. W. N. Hartley, D.Sc., F.R.S., to the Chemical Section of the British Association at Southport contains little of an immediately electrical character, but it is highly interesting to all students of pure science as showing how researches in one direction frequently add to our knowledge in another, although the two subjects may apparently be totally disconnected. The paper consists of a review of 25 years' experimental work in that branch of chemical physics which deals with the emission and absorption of rays of measurable wave length, and it is therefore divided into two portions, dealing respectively with absorption and emission spectra. The former part is wholly outside our purview, and it must suffice to say that an examination of the absorption spectra given by numerous organic chemical substances has not only often settled their true constitution when chemists have found difficulty in deciding it, but has also brought to light optical relationships between allied compounds analogous to other relation-

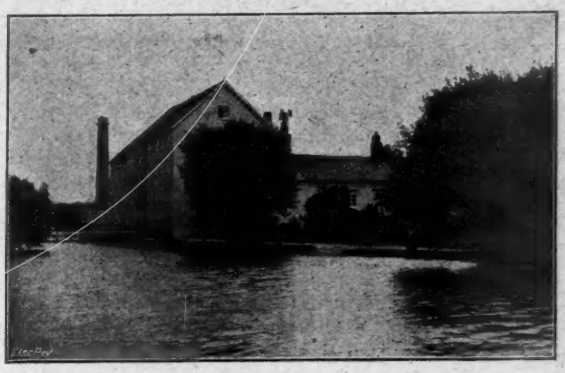
ships of a chemical or physical character. In a very similar fashion a study of the emission spectra given by metals has shown that the lines, or groups of lines, yielded by allied metals vary in position or relative intensity in a manner which enables many of those metals to be arranged in parallel and series so as to agree with the Periodic law; and has, in fact, led to a new definition of an "element," as a body whose spark spectrum has been found to be different from that of every other known form of matter. Moreover, since the spectra of definite groups of (monatomic) metals are similarly constituted, it has been deduced that they are yielded by similarly constituted molecules; whence it follows that the atoms are of complex constitution. Thus groups of elements with similar chemical and physical properties, where the atomic weights differ by fixed definite values, are composed of the same kind of matter; the matter of the different elements being in different states of condensation, as it is in different members of the same homologous series of organic compounds. The atomic theory suffices to explain the laws of combination and decomposition as shown by the balance (which indicates only masses of tangible size); but spectrum analysis renders it conceivable that matter in the state of gas or vapour might become so attenuated that repulsion of the molecules would exceed attraction, when aggregates would no longer be formed and weighing would become impossible. "In such a condition they may be imagined to constitute the ether, and in view of this conception there may be recognised four physical conditions of material substances, viz., solid, liquid, gas, and ether."

Inter-urban Car Tests.

UNDER this title the *Street Railway Journal* for July 11th records the *précis* of results arising from a series of simple but useful tests carried out on the inter-urban road between Muncie and Indianapolis. The tests were taken primarily for the information of the operating company, and nothing original was expected or obtained, but some of the figures are instructive to the outsider. Local, or stopping cars, are run between "limited" or express cars, and three "cities" are served. The schedule speed of the locals for the whole run is 23 miles per hour, and for the country run 27 miles per hour. It makes an English traffic manager's mouth water to hear that the schedule speed in Indianapolis is 10·28 miles per hour. As usual, the maximum consumption of energy per car-mile occurs in the towns, this being due to lower speeds, higher acceleration, more frequent stops, dirtier rails and lower voltage (sometimes), than are obtained in the country. For instance, the average units per car-mile for town service average 5·88, and for country service only 2·87, an astonishing difference of over 100 per cent. Again, the local trains take 25 per cent. more energy than the limited trains over the whole journey, the former making an average of 34 stops per journey, outside the towns. Proving how much difference there is between cars of the same weight and equipment, due to the state of health of individual cars, a difference of 49 per cent. was recorded between two cars going one way. Running conditions were as identical as could be expected. Averages for the day showed a difference of 21 per cent. between these cars. Experience in other tests makes it reasonable to believe that the personal equation of the motor men need not be considered. The tests further indicated that the better men were handling the faster cars, but the results obtained on single trips with individual motor men were quite confusing and seemingly inconsistent. The most economical man one way would be the most extravagant on the return journey, and, of two men, the average of one going east was 8 per cent. higher than his average going west, while the average of the other was 6·5 per cent. higher on the westward than on the east-bound trip.

THE N.S. SECONDARY CELL.

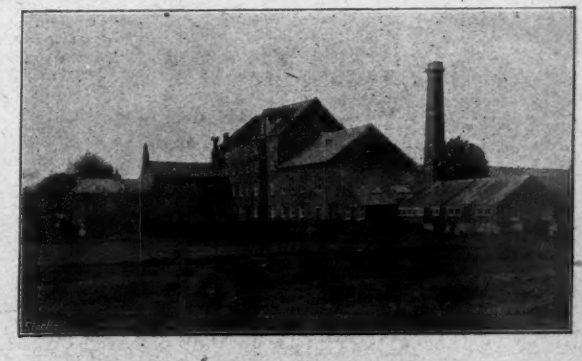
FOR some considerable time Mr. J. T. Niblett, well known in connection with storage batteries, has been engaged in perfecting a new type of cell, in which several novel features are embodied. Departing boldly from conventional lines, Mr. Niblett has adopted the solid form of cell for stationary purposes, and has attained a marked degree of success. We were recently favoured with an opportunity of inspecting the cell at the works, where it is manufactured—the Old Mill House, Horton Kirby, Kent. The construction of the cell is shown by the drawings given overleaf. The active material consists of pellets or small cylinders, about $\frac{5}{16}$ in. in diameter and the same length. These are made by compression in die plates, and when dry are exceedingly hard; at the same time they are very porous, and will absorb



N.S. BATTERY WORKS: VIEW SHOWING THE OLD MILL DAM.

a considerable amount of the electrolyte. The pellets are packed in a porous pot round the positive electrode, of the form shown in the figure, while the space between the pot and the lead containing box (the negative electrode) is packed with disintegrated lead. A wooden case surrounds the whole. One of the advantages claimed for these cells is that, should the electrolyte escape by any means, it would not stop the discharge, as such a large quantity of solution is absorbed in the pores of the active material and the separator, that it allows action to go on for some considerable time. Cells have been emptied and then discharged at the normal rate, and have given half their normal capacity under these conditions.

Three distinct types of cell are made; the solid, which is more suitable for large electric lighting installations, central stations and tramway work, is considered the best, as in its present form it can be supplied at low rates, and it has the advantage that short-circuiting has practically no injurious effect. Owing to the enormous amount of exposed active material on both the positive and negative sides, very high rates of charge and discharge may be taken from the

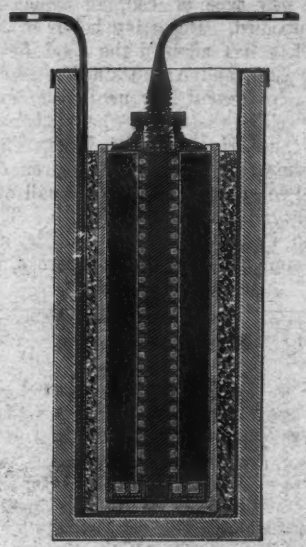


EXTERIOR OF N.S. BATTERY WORKS.

cell without in any way injuring it. It is stated that even if excessive rates of discharge were taken from the elements, so as to cause slight expansion and disintegration, this would do no harm, as the material would tend to settle at the bottom of the cell, and would in time solidify and become active, so that no loss in capacity would occur.

D

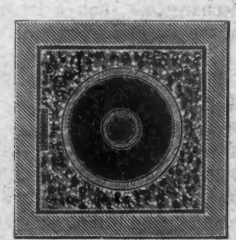
The second type is termed the semi-solid accumulator; this is built up of special grids, which are thick, and contain a large amount of active material. This material is of the same composition as that used in the solid cells, and, being



N.S. Secondary Cell. Vertical Section of "Solid" Type.

highly porous, may be used in thick masses. In this case ribbed porous plates are employed for the separators, and the elements are held together by stout clamping plates, which really constitute the outside negatives of the sets of elements. These clamping plates are pressed together by connecting bars having a flange at one end and an india-rubber pad pressing against this, so as to allow for expansion and contraction during the charging and discharging operations. These cells are used for low capacity batteries, and in cases where a small and light battery is required, also for motor-car driving.

The third type of cell is termed the portable type; these are supplied made up into



Horizontal Section of N.S. Cell.

batteries ranging from two to six cells for medical purposes, carriage lighting, X-ray work, actuating small electromotors, and for ignition purposes for petrol engines and motor-cars. In constructing these cells, which are also of a semi-solid type, the first consideration has been durability, and the elements are of a very robust character, well calculated to withstand the jerking and jarring which they may receive when on vehicles or when being carried about. The elements are mounted in vulcanite or celluloid cases, enclosed in a hard-wood containing box, and are fitted either with two terminals, or with terminals to each cell as required.

The makers state that the cells behave much in the same way as the ordinary form of accumulator. The electrical pressure of the cells immediately after charging is about 2·2 volts, but this quickly sinks to the normal 2 volts. On the discharge the fall of potential is proportional to the rate of discharge, but to discharge down to 1·7 volts for a lighting circuit is quite permissible, and in the case of tramway and power circuits they may be discharged down to as low as 1 volt per cell. This apparently does not injure them in any way.

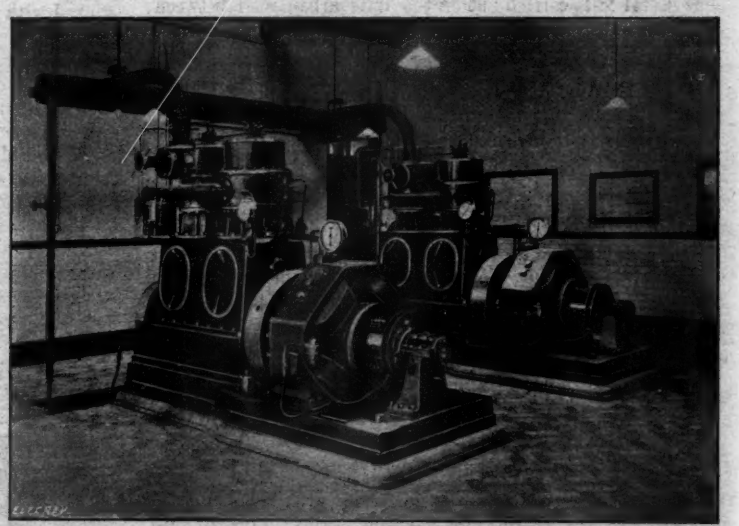
As much as 95 per cent. quantity efficiency and from 70 to 75 per cent. energy efficiency has been obtained with both the solid and the semi-solid types of cell. The capacity per pound of complete cell, in the case of the solid batteries, is about four watt-hours. In the case of the smaller cells it may be somewhat less, but as the capacity of the cell increases, the capacity per pound of complete cell tends to increase, a condition not usually met with. In the case of the semi-solid cells, about 10 watt-hours per pound of complete cell are obtained, but this, of course, is regulated by the nature of the containing boxes, whether they are of vulcanite, glass or lead-lined wood. With the small portable batteries, capacities have been obtained up to 12 watt-hours per pound of complete cell.

A solid cell made up some 15 months ago was taken out of a battery, discharged, and then emptied, and was allowed to stand idle for a matter of four months. At the expiration of this time the cell was filled up with electrolyte, and put on charge, and after one or two charges and discharges it was found to be in perfect condition.

The cells have been frequently short-circuited, but no detrimental effect seems to occur; they have also been run down until they showed absolutely no pressure whatever, and on the re charge they appeared to come up quite well. This is believed to be due to the fact that the elements have an enormous amount of exposed surface, and the active material cannot disintegrate or leave the conductor. The simple construction of the "solid" cell, rendering skilled labour superfluous, both in manufacture and in working, is one of its most prominent features.

The works consist of a five-storey building, which has been entirely reorganised and adapted to the manufacture of storage batteries. The usual workshops are provided, with steam power plant, electrical and chemical laboratory, stores, battery room, &c. Water power is derived from the River Darent, which runs through the grounds, by means of turbines, and electricity is generated for charging the new batteries, lighting the works, and supplying the adjoining dwelling-house—Mr. Niblett's residence.

The manufacturing business is owned by the "N.S. Electric Storage Co., Ltd.," while the selling arrangements



Burnley Union Workhouse: Generating Plant.

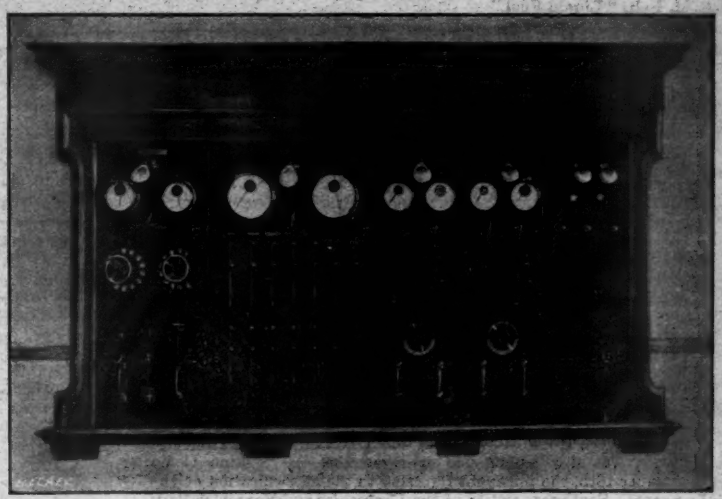
are in the hands of Mr. F. J. Down at the London offices, 139, Queen Victoria Street, E.C. We wish every success to Mr. Niblett and his associates in the new venture.

BURNLEY UNION WORKHOUSE LIGHTING.

The accompanying views are representative of the generating plant for the electric lighting of the numerous buildings comprised in the above-named institution, which include the workhouse, male and female pavilions, imbecile blocks, infirmary, casual wards, cottage homes, and several minor buildings.

The area thus covered is about a quarter of a mile, and each separate block is supplied with current from the

generating station by means of underground concentric lead-covered feeders. The wired installation represents the equivalent of 2,500 lamps of 8-C.P. The station buildings include boiler house, 34 ft. by 62 ft., with two Lancashire boilers installed, each 9 ft. by 30 ft., and space for a third to be added. At the rear of the boilers is fixed a Green economiser, consisting of 96 tubes, the scrapers for which are driven by a small electric motor. The boilers, apart from supplying steam at 130 lbs. pressure for the electric light engines, are also used to supply steam, through reducing valves, for heating and other purposes. Adjacent to the boiler house is the pump room, containing a Worthington feed pump, and also an injector, together with the necessary tanks, piping, &c., and in the same room is placed the feed-water heater fed by the exhaust steam from the engines. Leading from this room and through the oil store is the engine room, measuring 34 ft. by 27 ft. and 24 ft. high, with top and side lights. This room has a wood block floor and tiled walls, and contains the generating plant, consisting of two Reavell high speed compound two-crank engines, each of 75 H.P., connected direct to multipolar shunt-wound dynamos of the Phœnix Dynamo Manufacturing Co.'s make, each of 36 KW. at a voltage of 225. Space is provided for a third set, to accommodate which a spare dynamo panel is allowed for on the switchboard. This board is 10 ft. high by 12 ft. wide, and consists of cell panel, circuit panel, and dynamo panels. The back of the board is situated in the cable room, 22 ft. by 12 ft., from which room all the underground feeders start to the various buildings. A booster is also fixed in the engine room for adding the necessary voltage to the cell-charging current. This machine is of the single field type with double armature, the motor voltage being 225, and the generator 10 to 60 volts and 60 amperes. The cell room is a large and lofty apartment, opening from the engine room, and contains 120 E.P.S. 13-plate WS type cells with a maximum discharge of 90 amperes for two hours. This battery is used for supplying the all-night load of night lights, &c., in the wards and corridors, also the light day load furnished by the small motors. The remaining room leading from the engine room is the repairs or work room, and over this is the water storage tank for the boilers. This tank measures 24 ft. by 16 ft. by 5 ft. deep, and is fed with water pumped by a Blake-Knowles three-crank pump worked by an electric motor, from a well about 400 yards away. A town's water supply is also led to the tank in case of failure of the other supply from any cause. The whole of the station buildings are substantially built of dressed stone, as also is the square chimney, which latter is 120 ft. high and 9 ft. wide at the base. The whole of the lighting is done by means of incandescent glow lamps, and the plant and installation were completed and put to work in October last. The resident electrical engineer is Mr. Albert Moorhouse, and the consulting engineers who designed the installation are Messrs. Shepherd & Watney, of Leeds.



BURNLEY UNION WORKHOUSE: MAIN SWITCHBOARD.

THE BRITISH ASSOCIATION, SOUTHPORT, 1903.

THE meetings of the sections came to an end on Wednesday last week, September 16th, and the following is a list of the reports and papers which came under consideration during the week's sittings:—

Presidential Address to Section A, on radium and other things, by Mr. C. V. Boys, F.R.S.

Presidential Address to Section G, on a summary of recent engineering progress, with special reference to waterworks, and some passing references to electric lighting, traction, wireless telegraphy, &c., by Mr. C. Hawksley.

Lord Kelvin on "Electro-Ethereal Theory of the Velocity of Light in Gases, Liquids and Solids."

Prof. E. Rutherford, F.R.S., "On the Nature of the Emanations from Radio-active Substances." This paper gave rise to a prolonged and interesting discussion, which was followed by a large audience. The contributors to the discussion were Sir Oliver Lodge, Lord Kelvin, Profs. Armstrong, Schuster, Dewar, Larmor, Boltzmann, Tronton, and Messrs. Lowry, Soddy, W. C. D. Whetham, and others.

Messrs. Elster and Geitel, "On the Radio-Active Emanations Present in the Earth's Crust and Atmosphere."

Prof. A. Schuster, F.R.S., on "Cosmical Radio-Activity."

S. H. Turner, M.A., on "Depreciation and Sinking Funds in Municipal Undertakings."

J. Swinburne, "On the Treatment of the Thermo-Dynamics of Irreversible Processes." [This paper was printed in our last issue. It created a discussion in which Prof. J. Perry, Dr. Larmor, Prof. Boltzmann and Mr. Whetham engaged.]

Dr. J. H. Reynolds, "The Equipment of the Manchester Municipal Technical Institute." The Institute was visited by Section G the day after the reading of the paper, and a number of speakers preferred not to discuss the matter until after seeing the departments and equipments. A description of the Institute was given in the ELECTRICAL REVIEW for October 31st, 1902. Dr. Reynolds prefaced his description by replying to some remarks made in the *Times* by Prof. Armstrong, who said that the undertaking would turn out to be a "white elephant" for Manchester. The doctor asserted that the only thing that would make a "white elephant" of it would be the lack of a sufficient number of suitable students, between the ages of 16 and 18, upon whom to work."

"The Report of the Committee on the Resistance of Road Vehicles to Traction." This report was summarised in a most interesting way by Prof. Hele-Shaw, and the meeting was obviously impressed with the importance of the work that had been done. We shall print the report in due course.

T. Clarkson, on "Developments in Automobile Construction." The author explained many important directions in which he and others had made progress in the design and construction of steam motor-cars, and his paper was followed by a discussion, in the course of which unstinted eulogiums of Mr. Clarkson's work were offered by motor-car specialists.

Lieut.-Col. Crompton, on "The Problem of Modern Street Traffic. [This was dealt with in our last issue.]

Dr. W. J. S. Lockyer, "Spectra of Lightning."

Messrs. J. E. Petavel and R. S. Hutton, "Peliminary Note on Some Electric Furnace Reactions Under High Gaseous Pressure."

"Report of the Committee on the Small Screw Gauge." [This was not read, but is to be printed in the *Proceedings*.]

W. B. Woodhouse, "Protective Devices for High-Tension Electrical Systems."

J. B. C. Kershaw, on "Aluminium as an Electrical Conductor [See E.R. September 18th, p. 450.]

E. Wilson, on "The Electrical Conductivity of Certain Aluminium Alloys, as Affected by Exposure." [See E.R., September 18th, p. 451.]

E. Wilson, on "A Method for Finding the Efficiency of Series Motors."

B. Hopkinson, on "The Parallel Working of Alternators."

J. N. Shoolbred, "On Electrical Propulsion as the General Means of Transport."

Prof. H. L. Callendar, F.R.S., on "Self-recording Instruments."

H. E. Wimperis, "A Further Note on Gas Engine Explosions."

E. G. Izod, "Pendulum Apparatus for Testing Steel as Regards Brittleness."

W. Odell, "Preliminary Experiments on Air Friction."

W. Cramp, "The Single-phase Repulsion Motor."

J. W. Thomas, "The Ventilation of Tube Railways."

Dr. R. T. Glazebrook, F.R.S., "Report of the Committee on Electrical Standards."

Messrs. R. S. Hutton and J. E. Petavel "Note on Carbon and Iron Arc Spectra at high Gaseous Pressures."

P. H. Powell on "Consideration of some Points in the Design and working of Ballistic Galvanometers."

Prof. E. W. Marchant and G. W. Worrall "On the use of Capacities as Multipliers for Electrostatic Voltmeters in Alternating Current Circuits."
Rev. A. L. Cortie, on "Solar Prominences and Terrestrial Magnetism."
L. A. Bauer, "Progress of the Magnetic Survey of the United States."
L. A. Bauer, "The Earth's Total Magnetic Energy."
W. F. Goodrich, "Twenty-five Years' Progress in Final and Sanitary Refuse Disposal."
F. B. Behr, "High-speed Express Mono-rails and the Manchester and Liverpool Express Railway."
A. M. Bell, "Liquid Fuel."
Prof. George Forbes, "Further Experiences with the Infantry Range Finder."
R. Pearson, "History of the Discovery of Natural Gas in Sussex."

Southport being the head-quarters, it was possible to arrange a number of most profitable visits to electrical manufactories in the neighbourhood. The works of the British Insulated and Helsby Cables, Ltd., at Prescot; those of Messrs. W. T. Glover & Co., at Trafford Park, were visited by a party of Section G. On Saturday, September 12th, some 200 members and friends journeyed from Southport to Manchester, chiefly for the purpose of inspecting the works of the British Westinghouse Co.

The visitors were conveyed to Trafford Park on Manchester Corporation electric cars, and thence to the Westinghouse works on the estate company's cars. The party was conducted through the various buildings, and the chief manufactures of the company, comprising steam turbines, gas engines, electric generators, motors, arc lamps, &c., were noticeable in every stage of construction, and many instructive object lessons were presented in the general lay-out of the shops. Luncheon was provided by the management at the conclusion of the tour, and the party left the works *en route* for the city, where Rylands Library, Cheetham College, and the Municipal Technical Schools were inspected.

A visit to the Horwich works of the Lancashire and Yorkshire Railway, was also among the arrangements. In Section G on September 16th, the president referring to the electrification of the Liverpool—Southport section of the Lancashire and Yorkshire Railway, said that Mr. Worthington had sent a few details of the work. The conversion was going on without any interference with the ordinary traffic. There was to be a large power station at Formby, and there was a conductor rail at the side of the running rails. A steel return rail was laid between each pair of running rails. With regard to the electric equipment, three-phase alternating current would be used, and would be conveyed by three-core high-tension cables laid on the solid system and placed generally in the 6-ft. way. There would be two sub-stations at which the high-tension three-phase current would be transformed to low tension, in static transformers, and afterwards it would be converted to direct current at 600 volts for use in propelling the trains.

Next year's meeting of the B.A. takes place at Cambridge, with Mr. Balfour as president. In 1905 South Africa will be visited.

SCREW GAUGE REPORT.

(Section G, September 14th.)

Mr. W. A. Price, M.A., as recording secretary, reported that the Committee on the Small Screw Gauge had had two meetings, and substantial alterations had been made in their report, which would be presented by the Committee later. It was not possible to read the report at that meeting. It would be included in the printed papers.

PRELIMINARY EXPERIMENTS ON AIR FRICTION.

By Wm. Odell, A.R.C.Sc.

(Abstract, Section G, September 16th.)

These experiments were begun with the object of finding a convenient method of determining the power wasted by the windage of fly-wheels and dynamo armature. The experiments described at length were made with paper discs, which were mounted on the shaft of an electric motor.

The excitation was kept constant, so that the torque was proportional to the current. Thus the extra current required to maintain a given speed after the disc had been fixed to the shaft gave the torque absorbed by the disc.

There was found to be an angular speed for each disc above which the torque was accurately proportional to about the 2·5th power of the speed. This critical speed appeared to vary inversely as the square of the diameter. Below it the law followed was of a lower degree; but owing to the multiplication of errors of measurement no definite conclusion as to its exact nature was arrived at.

As the three discs originally tried gave uncertain results as to the effects of size, a much larger one, nearly 4 ft. in diameter, was also tried; and as a result of all the experiments it was concluded that the torque varies as about the 5·5th power of the diameter.

To give an idea of the amount of power thus absorbed, it may be stated that a disc of 47 in. required $\frac{1}{10}$ H.P. to keep up a constant speed of 500 revolutions per minute, and that if the above law holds a 9-ft. disc would absorb 10 H.P. at the same speed.

This paper was read for the author by Mr. W. Cramp, who opened the discussion by asking whether it was going to pay steam-engine builders to enclose their fly-wheels in wood, in view of the results of these experiments. From all he had been able to see, it was extremely likely that the loss by air beating about the wood casing would be as great as when the wheels were open.

Prof. Ayrton said that there was a great difference between a wheel with spokes and a continuous disc. It was very possible they would find an improvement by filling up.

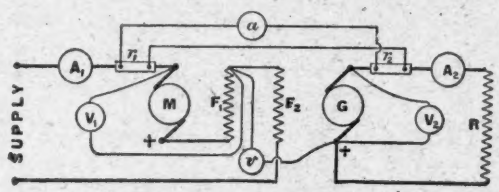
Captain Sankey said that he would like to ask whether it was a question of rim velocity or revolutions? He had a distinct recollection of a case in which a fly-wheel was boxed in with very considerable advantage. The one referred to was a low speed engine, but the peripheral speed was high.

A METHOD FOR FINDING THE EFFICIENCY OF SERIES MOTORS.

By Ernest Wilson, Professor of Electrical Engineering, King's College, London.

(Read before Section G, September 14th.)

The following method has the advantage of great accuracy, and I have found it work well in practice. The figure gives a diagram of connections in which M and G are two like machines mechanically coupled together, either through or without gearing, according as it is desired to obtain the efficiency of either machine inclusive or exclusive of gearing. In the test M runs as a motor and delivers its energy to G running as a generator. The field coils F_1 F_2 are placed in series with one another and with the motor armature in order that each machine may be conveniently magnetised to the same degree in any test. The input of the motor is measured on the voltmeter V_1 and ammeter A_1. The generator is loaded on a resistance, R, and its output measured on the voltmeter V_2 and the



Efficiency Test Connections.

ammeter A_2. Let R_1 and R_2 be the ohmic resistances of the motor and generator armatures respectively, then $V_1A_1 - V_2A_2 = X$ are the total watts dissipated in the system exclusive of the generator field coil F_2. Of these $A_1^2(F_1 + R_1) + A_2^2R_2 = Y$ are the ohmic resistance losses in watts, and $X - Y$ are the watts due to brush, bearing and wind friction, eddy currents and magnetic hysteresis. The machines are equal and rotate at the same speed. $\frac{X-Y}{2}$ are the watts which can be debited to each machine when calculating efficiency, it being assumed that the brush contact resistance has the same value as when measured with the machines at rest, and that armature reaction does not produce inequality in the watts dissipated by eddy currents and magnetic hysteresis in the two machines. The expressions for the efficiencies are, for the motor, $\frac{X-Y}{2} + V_2A_2 + A_2^2R_2/V_1A_1$, and, for the generator, $V_2A_2 \Big/ \frac{X-Y}{2} + A_2^2R_2 + A_1^2F_2 + V_2A_2$. The above, so far, is a well-known method, and has been described by Mr. Field. The extension here described consists in the addition of two low-resistance shunts, r_1r_2, a milli-voltmeter, a, and a voltmeter, v. By these instruments the differences $A_1 - A_2$ and $V_1 - V_2$ have been measured as direct quantities. It is easy to show that greater accuracy can be obtained by measuring A_1 and a and using the value $A_1 - a$ instead of A_2, and measuring V_1 and v and using the value $V_1 - v$ instead of V_2. For instance, let $V_1 = 500$, $A_1 = 50$, $V_2 = 450$, $A_2 = 42$, $R_1 = R_2 = F_1 = F_2 = 0{\cdot}5$ ohm, and let there be a liability for error of 1 per cent. in reading the instruments. Then the possible error in the value of $X - Y$, when $V_1V_2A_1A_2$ are the measured quantities, is 31·9 per cent., whereas it is 1·9 per cent. when V_1vA_1a are the measured quantities.

ON SINGLE-PHASE REPULSION MOTORS.

By William Cramp, A.M.I.E.E.

(Read before Section G, September 16th.)

It is a matter of common knowledge that if it were possible to construct a single-phase alternate-current motor having the characteristics of a direct-current series motor, and no serious drawback, it would find a very extensive application, on account of its extreme suitability for the transmission of power, especially in connection with railway work on long lines. There are many forms of single-phase induction motor on the market, some of which are, for certain purposes, very useful. Yet, in spite of these, the single-phase motor is avoided wherever possible, as is clear from the many costly alterations which are being carried out in this country. It is only necessary to mention a few examples of this. In Croydon a direct-current plant has been laid down for the centre of the town, solely to provide for motors, in addition to the already existing alternating supply. The City of London Electric Lighting Co. are

slowly replacing alternating by direct current for similar reasons. The towns of Coventry and Sheffield are introducing two-phase in place of the existing single-phase system. No doubt much of this will be changed if the Baltimore and Annapolis Railway is successful, since that will demonstrate the existence of single-phase motors comparable to the direct-current series motor, and the extreme simplicity and flexibility of the single-phase system will again recommend its adoption in cases where three-phase plant is now in contemplation.

At present there is a choice of three types of motors on single-phase systems.

1. *The Synchronous Motor.*—The disadvantages of this form, where starting and stopping are frequently necessary, are sufficiently obvious.

2. *The Asynchronous Induction Motor.*—The disadvantages of this motor are that special devices, always cumbrous and often very expensive, must be employed to start it up, and even then a current usually considerably in excess of the full-load current is needed to run it up to speed under load—often a grave objection on lighting circuits. Moreover, even under favourable conditions, the power factor is poor, the efficiency not high, the possibilities of varying the speed almost nil.

FIG. 1.

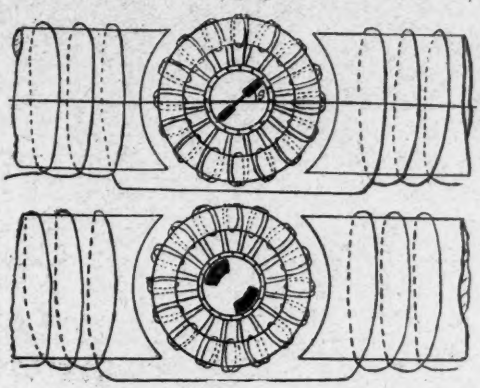


FIG. 2.

3. *The Series Alternate-Current Motor.*—This motor bids fair to rival the previous forms for general application, and will, as we have said, be thoroughly tested on the Baltimore and Annapolis Railway. Its disadvantages are that the frequency at which it is most successful is very low, thus rendering it inadmissible on lighting circuits, while its power factor tends to decrease with load, and pressure difficulties at the commutators are almost unavoidable.

The only other type at present practicable is the repulsion motor. For several years past I have been working to ascertain the lines on which really efficient and satisfactory motors of this type might be designed, and I now believe that repulsion motors may be built up to at least 20 H.P., which will compare favourably with any type of motor at present in use. In its simplest form the repulsion motor consists of a laminated electro-magnet or stator excited from the single-phase mains, and an armature or rotor wound almost exactly like the armature of a direct-current machine, and fitted with a similar commutator. Brushes rubbing on this commutator are set at a particular angle and short-circuited. The alternating flux set up by the stator induces in the coils of the rotor currents in such directions that the coils carrying them tend to move out of the inducing field. The action is exactly the same as that shown by Prof. Elihu Thomson to exist when a plain copper ring is brought into the field of a solenoid excited by an alternating current.

Figs. 1 and 2 show clearly the two main forms of repulsion motor. In fig. 1 the angle is usually 45° or less. This type has the following peculiarities:—(*a*) the E.M.F. of a quarter of the rotor opposes that of the other three quarters, leaving half the rotor for the useful E.M.F.; (*b*) the rotor current passes through all the coils, whether in a useful position or not, thereby increasing the C^2R loss; (*c*) a quarter of the rotor gives a torque opposing rotation; (*d*) individual coils short-circuited by the brushes are constantly giving a torque opposed to rotation, and so cause difficulties with commutation. These disadvantages led me to construct repulsion motors on the lines of fig. 2; and it is partly due to the adoption of this form that I have succeeded in obtaining satisfactory commutation. The difficulties of construction, chief among which is commutation, have led most writers to speak of repulsion motors with much distrust. Thus Elihu Thomson, whose patent of 1889 covers the whole principle of repulsion motors, refers to them as capable of giving out considerable power, "though with what economy is unknown." Prof. Jackson condemns them as "bulky, expensive, and inefficient," though he adduces no evidence in favour of this verdict. Mr. Steinmetz writes, "they have the disadvantage of using only part of the rotor," but as recently as December, 1902, he said that he believed better results were to be obtained from them than from series alternate motors. To show how very misleading are these statements, I here add:—(1) That Mr. Parshall proposes using only 50 per cent. of the armature for his recent direct-current machines. (2) If the coils of the rotor are only half of them used at any given instant, it is obviously possible to work at a higher current density. In one of my experimental motors I have had eight ampères through No. 21 wire without serious heating. (3) In such alternators as the Mordey-Victoria, only half the armature is ever really active at one time.

The chief difficulties in the construction of repulsion motors are:—(1) Liability to vicious sparking; and (2) difficulty in obtaining a high power factor. In the first form of repulsion motor which I tried I found that the spark was almost as great on closing the coil as on opening it. In order to investigate this, I had some experiments carried out on the opening and closing of circuits, of which I now relate briefly the results. With an inductive circuit there was less tendency to spark on the make than with a non-inductive circuit, and there was much less tendency to spark on the make with copper than with carbon contacts. I find, on the whole, that to avoid sparking on the make, a good, firm, clean, low resistance contact is adequate. For this reason I have so far used copper brushes in the motor, but, despite this, the choice between carbon or copper has to be decided by the consideration of the whole of the circumstances, which would be too long to discuss now. With copper brushes I have been able to get absolutely sparkless commutation, working from nothing to full load, on a motor whose design was distinctly faulty. These results refer more particularly to motors of the class represented by fig. 2, whose only disadvantage is the long arc of brush contact, entailing corresponding friction. Having by copper brushes provided for closing the circuit sparklessly, I was enabled to obtain sparkless opening by means of the same principles that are employed in what is known as "resistance commutation"—that is, providing a sufficient interpolar space to enable each rotor coil to pass entirely outside the magnetic field, so that the current can die down before the opening of the circuit. It is obvious that a form of commutation might be employed corresponding to what in dynamo design I call "E.M.F. commutation" (a term which explains itself); or, better still, a combination of E.M.F. and resistance commutation, and as the output of the motor undoubtedly increases with pole width, it might pay to use one of these modifications, on which point, indeed, I am at present experimenting. In considering the actual design of a repulsion motor, the first object is to decide which form of commutation you are going to rely upon. Having settled this, the form of stator is practically fixed, for, if resistance commutation is to be relied on entirely, the stator must have distinct poles—by this I mean that there must be considerable air space left between one polar winding and the next, as in the direct-current machine. On the other hand, if E.M.F. commutation be used, the stator may be built exactly like that of an ordinary single-phase motor. I have tried both forms, and find that while both may be rendered sparkless between certain limits, the former gives good commutation over a wider range, while the latter

FIG. 3.

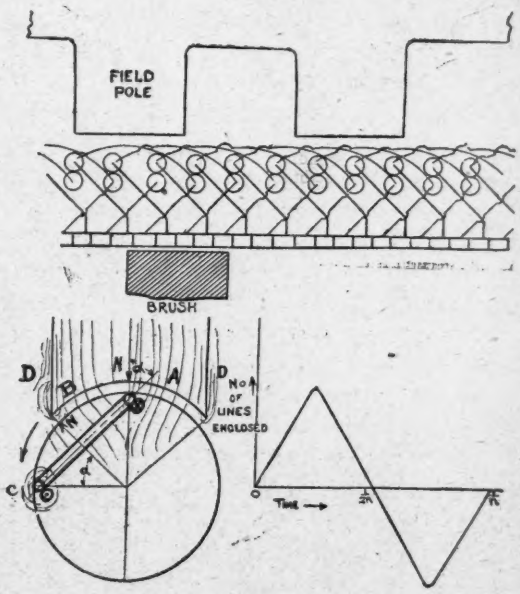


FIG. 4A. FIG. 4B.

gives better starting torque and better power factor. But I would insist on the fact that every form of repulsion motor may be rendered sparkless if the design of the rotor winding is properly considered. Thus, what has been hitherto the great disadvantage of the repulsion motor disappears.

We, therefore, proceed to consider the design of the rotor winding. We may choose an arrangement such as that in fig. 1, or a modification of fig. 2. The salient differences between these two forms are:—(1) in fig. 1 all the short-circuited coils are in series, while in fig. 2 they are in parallel; (2) in fig. 1 the rotor current always passes through the whole of the rotor coils, whether active or useless; in fig. 2 this is obviously not the case. If the rotor winding has to carry a large current, fig. 2 is not very suitable on account of the fact of the large heating that takes place at the commutator, and the large proportion which brush resistance bears to the resistance of the coil lying between any given pair of segments. I have already stated, under the head of "Commutation," other reasons for selecting windings of the type of fig. 2, but I ought to add that recent experiments with windings of the type of fig. 1 impress me very favourably, and all motors at present under con-

struction are of this type. In actual experiment with windings like fig. 2, I have found that if the rotor is of the closed-coil type, as shown, besides those coils actually short circuited, there are other closed circuits carrying useless, or even harmful currents. Hence, in the particular motor on which most of these experiments were made, the winding has been altered to that of fig. 3, thus practically converting the rotor into an open-coil armature, with two coils in parallel.

These considerations determine the type of rotor winding, and we now pass to the discussion of the E.M.F., current, torque, &c., taking first the case of a bipolar motor with a single coil, as in fig. 4A. This diagram is really a simple case of fig. 2. If the pole arc is 50 per cent. of the pole-pitch, and equal to the width of the coil, and the distribution of magnetic flux radially around this pole arc is sinusoidal, then the E.M.F. set up in the coil is a pure sine wave. If, however, the flux is distributed *uniformly* radially over the pole arc (as is more probable in an actual machine), the lines enclosed by the coil when the field is constant are as represented in fig. 4B. This is a sine wave with some odd harmonics, which

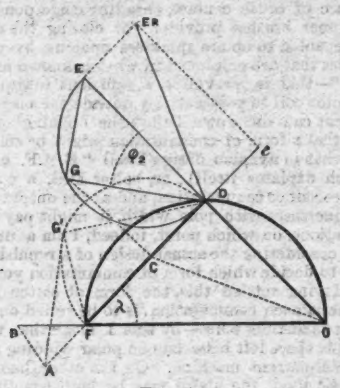


FIG. 5.

are of small importance in the present case; the third harmonic, which is the largest, has an amplitude of only 1/9 the fundamental. I shall assume, then, for present purposes, that both the time variation of the main flux and the time variation of the area of the coil with respect to the total flux are sine functions. We then have, if number of turns on the stator winding $= t_1$, number of active turns on the rotor $= t_2$, maximum magnetic flux per pole $= \Phi$, speed of motor in revolutions per second $= n$, periodicity of stator current in periods per second $= f$, R.M.S. primary E.M.F. $= e_1$, R.M.S. secondary E.M.F. $= e_2$. Then it is found that

$$e_2 = \frac{e_1}{\sqrt{2}} \frac{t_2}{t_1} \sqrt{1 + \left(\frac{b}{a}\right)^2}$$

which means that the secondary E.M.F. may be represented by the resultant of two lines at right angles, as shown in the phase diagram (fig. 5).

(To be concluded.)

CONSIDERATION OF SOME POINTS IN THE DESIGN AND WORKING OF BALLISTIC GALVANOMETERS.

By P. H. POWELL, B.Sc., Fellow of Victoria University.
Communicated by Prof. E. W. MARCHANT, D.Sc.

(Paper read before Section A, September 15th.)

THE D'Arsonval type of galvanometer is, at the same time, one of the most accurate and one of the simplest of galvanometers, and, consisting as it does in a movable coil suspended between the poles of a strong permanent magnet, it is exceptionally suitable for use in the neighbourhood of powerful electro-magnets.

The following is a brief outline of the design of one of these instruments which was required for a special purpose, and may be of value to other persons requiring a similar type of instrument.

A ballistic galvanometer is usually designed to have a certain periodic time and a certain sensibility; it should be quick working, i.e., should be able to be brought to rest quickly at zero after the deflection has been read.

The deflection of the galvanometer is a measure of the quantity of electricity discharged through the instrument. Since to extend the theory so as to take into account the varying current through the coil leads to equations which can only be solved when the current is known as a function of the time, it is assumed that the discharge takes place before the suspended coil of the instrument has appreciably moved, consequently the periodic time must depend upon the time during which the discharge passes and can be fixed accordingly; the ratio of the periodic time of the galvanometer to the time during which the discharge takes place depending upon circumstances.

Now, if we consider a coil of n turns suspended between the poles of a permanent magnet which creates a uniform field of intensity H.

Then if a and b be dimensions of coil in cms.

M be mass in grams.

K be rad. of gyration.

C be the control (due to tension of strip) (dyne cms).

Then after the impulse has been given

$$M K^2 \ddot{\theta} = -C\theta \text{ neglecting damping, and hence}$$

time of free oscillation $T = 2\pi \sqrt{\frac{M k^2}{C}}$. (1)

Now the impulse on each vertical side of coil due to discharge

$$Q = H n b Q,$$

and hence for initial moment of momentum

$$M k^2 \dot{\theta}_0 = H n b Q a$$

$$\dot{\theta}_0 = \frac{H n b a}{M k^2} Q,$$

and hence the deflection $\theta_{max.} = \frac{H n a b Q}{\sqrt{M k^2 C}}$. (2)

From equations (1) and (2), it is possible to design an ordinary galvanometer; the only other consideration is the damping.

Now the angular velocity of the coil is $\dot{\theta}$. Hence E.M.F. generated in 1 cm. length of the wire is $\frac{a}{2}\dot{\theta} H$.

$\therefore$ Total E.M.F. induced in coil $= \frac{a}{2}\dot{\theta} H 2 n b$ (C.G.S.)

Current induced in coil $= \frac{H n a b}{R}\dot{\theta}$.

$\therefore$ Retarding couple on coil $= \left[\frac{H n a b}{R}\dot{\theta}\right] \times H \times n b \times a$

$$= (H n a b)^2 \frac{\dot{\theta}}{R}.$$

Introducing this term into the equation of motion

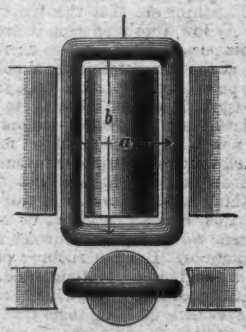
$$M k^2 \ddot{\theta} + \frac{(H n a b)^2}{R}\dot{\theta} + C\theta = 0.$$

Hence critical damping takes place when

$$4 M k^2 C = \left[\frac{(H n a b)^2}{R}\right]^2$$

$$\text{or } R = \frac{(H n a b)^2}{2\sqrt{M k^2 C}} \quad \text{C.G.S. units.} \quad (3)$$

In order that the motion of the coil may be effectively stopped by short-circuiting, its resistance must not be greater than the value given by this equation; when a deflection is being read, however, in order to render the damping term inappreciable, the total resistance of the circuit must be considerably greater than this value. This can be readily arranged by suitable connections. From these



FORM OF COIL AND MAGNET.

equations it is seen that in order to increase the periodic time of a galvanometer the moment of inertia of the suspended system must be increased, or the control decreased by using a single fine suspension; and if a high sensibility is desired either the moment of inertia must be decreased or the control decreased; so that in order to have both the high sensibility and a low period the control* must be reduced. If the period is brought down by other means there will be a loss of sensibility. As a matter of fact, the control cannot be reduced below a certain point, and so if a longer time of swing is desired, it can only be obtained at the expense of the sensibility.

In a special case a galvanometer was required to have a very low period with a fairly high sensibility and quick working, and this investigation was undertaken in order to obtain a satisfactory instrument.

From calculations founded on the above equations a design was made, assuming a certain size of coil and shape of magnet, which was sent to a certain firm of instrument makers so that they could inform us of the value of the strength of the magnetic field in the gap. This was found to be 230 lines per sq. cm., and from experiments on the torsional oscillation of phosphor bronze strip it was found that a control of ·01 would not be difficult to obtain. Assuming these values;—$a = 1{\cdot}72$; $b = 5$; $c = {\cdot}01$; $H = 230$; periodic time $= 80$ secs.

Sensibility $\frac{1}{2}$ radian per microcoulomb (i.e., $\frac{1}{2}$ radian as motion of coil).

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* There appears to be a discrepancy here; for high sensibility and low period, the moment of inertia should be reduced.—EDS. ELEC. REV.

From equation (1) $\varkappa k^2 = 1{\cdot}64$ . . . . . (4)

From equation (2) substituting value for $\varkappa k^2$

$$n a b = 185{\cdot}6$$

or $n = 22$ turns.

Now, if m = mass per cm. length of coil

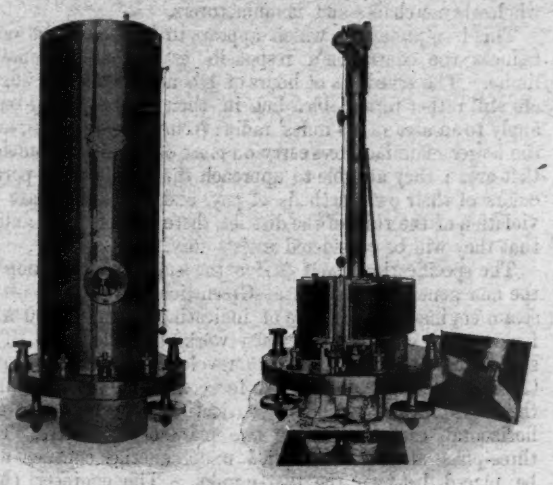
$$\varkappa k^2 = \tfrac{1}{2} m a^2 \left\{ b + \frac{a}{3} \right\}$$

or $m = {\cdot}2$ gms., giving No. 28 as the wire required.

Testing for damping in equation (3),

$$1{\cdot}64\,\ddot{\theta} + \frac{(230 \times 185{\cdot}6)^2}{R}\,\dot{\theta} + 01\,\theta = 0.$$

The critical resistance = 7·1 ω, which, being much larger than the resistance of the coil, indicates that the motion of the coil could be easily stopped by short-circuiting.



Ballistic Galvanometer.

From these results the galvanometer was constructed, and was found to have a much higher period and much lower sensibility than it had been designed for. The cause of this was not far to seek, lying in the fact that the copper wire used in the construction of the coil was magnetic, and it was found that this magnetic control was very large in comparison with the feeble control of the strip.

To overcome this difficulty various devices were tried, and wire was obtained from several manufacturers in the hope that it would prove non-magnetic. The best results were obtained, however, by depositing copper electrolytically on a very fine wire. The resulting copper wire was fairly non-magnetic, but so brittle that it could not be used. To improve the wire it was rolled between brass rollers and annealed, but in doing so some very fine iron dust floating in the air of the workshop must have become deposited on it, for it was again found to be magnetic. The amount of iron present was of course exceedingly small, but was sufficient to cause a disturbance in the total control. The attempt to produce pure copper wire was then abandoned, and in order to reduce the magnetic control a very narrow coil was procured, and by putting pole-pieces on the permanent magnet its field was made as uniform as possible, since in a perfectly uniform field magnetic particles on the coil would not produce any control. In order to increase the moment of inertia of the system a light copper disc was attached rigidly to the coil by a light bone rod. The disc-shaped form was adopted so as to have a large moment of inertia with small weight, thus saving the suspension from undue strain.

This arrangement when tried gave satisfactory results as regards sensibility and periodic time, but did not damp well when short-circuited. This difficulty was overcome by placing below the copper disc a small electro-magnet which, when excited quickly, brought to rest the disc by reason of the eddy current induced in it.

The photographs show the instrument when finished, one being an external view, and the other showing the internal arrangements. The length of the suspension (to obtain small control), and the various adjustments at the head are worthy of note, the whole suspended system being insulated.

There is one point of interest about the method adopted in calibrating the new instrument. This is done best by the standard solenoid, as the deflections are not proportional to the quantity of electricity discharged through the coil when the resistance in the circuit is small. Taking a series of readings, curves can be plotted showing the relation between flux—deflection for constant resistance, and resistance—deflection for constant flux, or the three may be plotted isometrically. This last is the most convenient method for odd deflections, but when several readings are taken with the same resistance, it is better to plot a separate curve connecting flux and deflection for each resistance from the set of curves connecting deflection and resistance for constant flux.

CORRESPONDENCE.

Aluminium.

With reference to the reports in your last issue (p. 452) of the discussion upon Prof. E. Wilson's paper on "The Electrical Conductivity of Certain Aluminium Alloys as affected by Exposure," may I point out that as regards my own contribution to this discussion, your reporter has made an error of some importance. When interrogated by Dr. Glazebrook as to the chance of sand having some influence upon my own results, I stated that the sand at Waterloo *would certainly carry salt*, but that my sample wires were in a sheltered place, and would not therefore be exposed to this influence.

Thanking you in anticipation for inserting this correction.

John B. C. Kershaw.

The West Lancashire Laboratory,
Waterloo, Liverpool, *September 18th*, 1903.

Electricity v. Gas.

The "Note," Electricity *v.* Gas, in your issue of Sept. 11th, is interesting reading, as showing the methods pursued by the gas companies to get customers, but some of the methods adopted by the electric lighting authorities do far more to help the gas companies than any display of mere figures, which very few people see, and still fewer trouble to understand.

As a case in point, I will mention the case of a small flat in the neighbourhood of Hammersmith. This flat (one of many in a block) is fitted up ready for gas-fittings, and the electric supply is laid just inside the front door.

The question of lighting being considered one goes into the matter of cost. A gas cooker is decided upon as a necessity, and so the gas company are requested to give a supply of gas, which they do promptly, fitting their meter free, and asking no deposit. They will, of course, supply light on the same terms.

The Borough Council, in answer to queries as to cost, &c., send along forms of agreement and regulations which look rather formidable, their ultimate result being that one finds the Council require a minimum of 13s 4d. for any one quarter during the year, and a deposit of £2 2s. This on an installation of six lights is a consideration, and in nine cases out of ten the gas company do the lighting.

It is interesting to note that the electric lighting department of Hammersmith borough made a profit of less than £150 for the year ending March, 1902, on an investment of some £170,000. A small consumer with four lights or so is beneath the notice of the Council, and one such who wanted the current was refused a connection to the mains, but was told to get a supply from his neighbour.

As our friend "Chordal" would say: "You will find knots in this thing."

College Court.

Smoke Abatement.

Mr. Daniell's letter in your current issue on smoke abatement drew my attention to your leader in the previous issue, which I had missed, and which I have since read with interest, as your remarks are very much to the point, especially those having regard to the "admission of air at a high temperature," the "quantity of air admitted," and also "the proper admixture of air and combustible when admitted."

Mr. Daniell's remarks *re* the various patents on the market are very true, for being especially interested in the question, as indeed all electrical engineers should be, especially those who are connected with the contracting and consulting side of the profession, I made it my business to make careful investigation of the majority of the better known systems, which are practically all forced draught systems, and which, as Mr. Daniell pertinently remarks, can have no real economy in use. I had practically given up the search; since then, however, a system has been brought to my notice which seems to me to perform the previously enumerated operations as nearly correctly as possible, and

to carry out Mr. Daniell's suggestion. Although it necessitates a closed ash-pit, it can hardly be termed a forced draught system, as in all of the various applications that I have seen, the air pressure in the ash-pit did not exceed a water-gauge pressure of $\frac{3}{4}$ in.

The method by which the above-named requirements are carried out in the case of Lancashire boilers is as follows:—Air intake pipes are placed in the main flue, and connected to the supporting tube boxes are two or more pipes, which pass through the flues of the boiler, and connect up to a blower operated by steam jets. This blower induces the air to flow through the intake pipes, at a sufficiently low velocity to allow the temperature to be raised 200-300° F., and then along the connecting pipes laid in the boiler flues, finally ejecting it partly in the ashpit, and the remainder through a series of jets placed at the back of the bridge, where it unites with the volatile gases, completing their combustion. As will be seen, the system fulfils the main points of controlling the air supply necessary for economical combustion, and is a step in front of Mr. Daniell's suggestion in that "heated air is supplied both behind the bridge and under the grate," and also the "quantity of air can be regulated by means of the cock controlling the supply of steam to the blowers," and the admixture of the air supply takes place on the right lines—viz., "partly under the fire and partly behind the bridge." It is, in my opinion, absolutely futile to supply the air, as is done by so many systems, all in the one place—viz., at the grate, even if heated, as the gases are not in a sufficiently advanced state of combustion and temperature to combine with the air, and so still further promote combustion, but are rather cooled down by the air supply, a percentage being carried off as free carbon, and partly deposited as soot in the flues and chimney, the remainder being carried away in the form of smoke, and emitted from the chimney in dense clouds.

The class of fuel which the writer saw being used was extremely poor, being the tailings which had passed through the $\frac{3}{8}$-in. mesh of the colliery screens, and it appeared to contain a considerable amount of dirt. The tests which had been taken by the purchasers showed an evaporation of slightly over 8·5 lbs. of water from and at 212° F. per pound of fuel.

The makers and patentees of the appliance are Messrs. M. B. Wild & Co., of Clarence Chambers, Birmingham, who informed the writer that their system was now being largely adopted by colliery companies, enabling them to utilise their low-grade fuel economically and smokelessly; also that some of their furnaces have been in operation for about two years, and, to the best of their knowledge, no repairs have been executed on them up to the present time.

Apologising for the length of this letter, and trusting it may be of service to some of my *confrères*.

H. H. B. Deane.

["G." wants to know who are the makers or selling agents of the Böhm lamp.—Eds. Elec. Rev.]

LONDON COUNTY COUNCIL TRAMWAYS.

Specification for Steam Engines.

Times change, and we change with them—often imperceptibly, it is true—but yet, if we compare the present with the past of a few years ago, we clearly see the difference. It was with feelings of this character that we perused the general conditions which accompany the steam engine specification recently issued by the London County Council.

Three years ago these were so stringent, and in parts so manifestly unfair, that many of the best known firms would not compete for work governed by such conditions; to-day the modifications which have been introduced render them, certainly not ideal, but at least workable.

The clauses which in the past caused such heartburnings were those relating to disputes, and the real or supposed liability of the main contractor for the actions of sub-contractors from whom he might obtain materials. The present arrangement with reference to disputes may be termed a compromise between the old system of the purchaser's engineer being the final arbitrator, and the modern plan by which *all* matters of dispute may, in the last instance, be referred to an outside impartial arbitrator. Here all matters relating to the manner in which the work is to be carried out, and questions relating to extension of time, are to be subject to the final decision of the Council's engineer; other disputes, including those relating to payments, are to be referred to an independent arbitrator appointed by the President of the Institution of Civil Engineers.

The liability of the main contractor for the action of sub-contractors is now limited to those directly working on the contract, and apparently does not apply to the manufacturer of materials or of articles required in the course of the work, which are ordinarily purchased wholesale in the market or of wholesale merchants and manufacturers.

This interpretation, which appears to be the correct one, reduces the contractor's responsibility within reasonable limits. The schedules of hours of labour and rates of wages are still rather formidable, but in their entirety they only apply to an area of 20 miles' radius from Charing Cross, and the larger manufacturers carry on most of their work outside that area; they are able to approach the Council with particulars of their own methods of pay, and unless these are in violation of the rules of the district, there is every probability that they will be considered satisfactory.

The specification itself is for the supply and erection at the new generating station at Greenwich of four 5,000-H.P. steam engines, each capable of indicating at least 6,500 H.P. for a period of two hours when working condensing. The speed must be either 94 or 125 revolutions per minute, and the engines must be arranged for compound working, with the high-pressure cylinders vertical and the low-pressure horizontal, each set having two pairs of cylinders. The three-phase alternators supplied under another contract will be placed between the two cranks. The engineer (Mr. J. H. Rider, electrical engineer to the L.C.C.) contents himself to a large extent with specifying results and leaving the contractor to find the means whereby the desired ends may be attained.

The following additional particulars may be of interest:—The generators will work at a frequency of 25 cycles per second; each set will have its own exciter, driven by ropes from the main shaft. The contractor is to state the fly-wheel effect (WR^2) that he requires to limit the cyclical irregularity within a maximum of ·15 per cent. up or down, the fly-wheel being supplied by the builders of the alternator.

Any successful type of valve gear may be used. The engines are to be built for use with steam superheated to 500° F.; eventually it will be superheated to 650° F., and passed through heating coils in the receivers, reaching the cylinder at 500° F.

The main shaft will be bored throughout; it will be carried in two main bearings, and the cranks, which are overhung, will be at an angle of 135°. The crank chambers will be wholly enclosed, and forced lubrication will be used.

The main governor must control the speed within a total range of 6 per cent. from no load to full load, or *vice versâ*, with a total variation of *not less than* 3 per cent. when the full load is thrown on or off; the governor will be electrically adjusted from a distance.

The steam consumption is specified as follows:—With 180 lbs. pressure, and a vacuum of 26 in.; per I.H.P.-hour:

Superheated steam (500° F.):	full load,	11½ lbs.;	half load, 13 lbs.
Saturated steam :	„	12¾ lbs.;	„ 14½ lbs.

For every ¼ lb. in excess of these figures, a penalty of £500 will be exacted in each case, with a corresponding bonus for better results. The tests are to be made when the sets are completed, and the engines are to be maintained by the builders for 12 months. We see no mention of a consumption test after 6 or 12 months' run—a very valuable check on the performance of the engines; neither is any reference made to an allowance for the power taken by the air and circulating pumps, in the steam consumption specified.

Although the tenderers are allowed a considerable measure of freedom with regard to the details of their designs, they are rigidly bound down in respect of the type of engine to be used—one which has been largely adopted of recent years in the United States, for large powers.

Doubtless this type possesses certain advantages, such as reduced friction, with only two main bearings: the simplicity of a two-crank engine: the greater cyclic regularity obtained with pistons at right angles, especially as the cranks are at an angle of 135°: the increased strength of construction with the centre-hung fly-wheel, &c.; but a far greater cubic space is required as compared with the vertical type, the makers of which, moreover, have the advantage of years of experience in similar work. The reduced wear and tear of large vertical engines, as compared with horizontal types, renders the former superior in this respect. The steam passages between the high and low-pressure cylinders are necessarily very long in the type specified, with correspondingly great radiating surfaces—none the less for the intervention of the reheater receiver—and their large capacity will render it obligatory for the governors to act on the low-pressure valve gear as well as on the high pressure, in order to obtain reasonably close governing. We are not admirers of the long overhung crank-pins of these engines, which, moreover, add to the difficulties of alignment, for, owing to the bending of the crankshaft, the high pressure cylinders cannot be put truly vertical. The shape of the long crank-pin, under the two stresses at right angles to one another, will always be spiral, and owing to these stresses the pin must have an unduly large diameter. Lastly, the balancing of engines of this type cannot be very satisfactory.

We may point out that the steam turbine, a native product, possesses so many advantages over the reciprocating type of engine, *especially* for large powers, that the adoption of these American peculiarities strikes us as a retrograde step. We shall shortly have the largest turbine-driven power station in the world at work in Chelsea. The engineer of the L.C.C. may have felt the immense importance of reliability in selecting the long-tried reciprocating type in preference to the turbine, which, although it has met with unparalleled success during the last 10 years, has certainly not been long in the field for large powers; but if this was the consideration which controlled his choice, why did he select an engine of abnormal type?

We illustrate elsewhere in this issue a 4,500-H.P. steam turbo-alternator which has given great satisfaction in Milan; why should a similar set not do as well in London—for but little larger power? In respect of uniformity of revolution and perfect freedom from vibration, the turbine has no equal, while it requires the minimum of space and foundations; moreover, a turbine can be run up from cold and put on full load in three minutes, where one of these eccentric machines would require 30. We certainly hope that this "freak" type of engine will never become popular in this country.

CENTRAL STATION AUXILIARY PLANT.

By FRANCIS H. DAVIES.

Of late years it has become an established fact that auxiliary plant plays a very important part in the economy of a power station. Some time ago it was customary to regard it as a necessary evil, upon the installation and upkeep of which as little money was to be spent as possible. The outcome of this feeling in one direction was the use of that kind of steam pump aptly described as the steam eater, and in all other directions, practice to a great extent followed much the same rule.

A consideration of station auxiliary plant is best undertaken in detail, with the greatest sinner against economy first, viz.:—

Pumps.—Whatever function a pump is called upon to undertake, whether feed, force, circulating, or air, the same power, either electricity or steam, may be applied to driving it; but the conditions under which pumps of the above sorts run being somewhat different, it cannot be said that either method holds the palm for all-round efficiency to the entire exclusion of the other.

In the case of a pump that is used intermittently, say for clearing out a sump, or pumping water into storage tanks, the motor-driven pump undoubtedly offers the greatest efficiency and convenience, as, besides saving condensation losses in steam pipes, it is always ready to start. Also the actual combined efficiency of the set will be higher than that of any small steam pump, owing to the fact that the latter do not usually act expansively, but carry their steam almost the full length of the stroke.

For sump-clearing an injector is frequently used, presumably because it is cheap, takes up small space, and requires little attention when working. Its efficiency, however, is very low, and its adoption can only be recommended where the infrequency of its use would render the cost of installing a motor pump too great. In many large stations the daily sump-clearing is a comparatively big business, and when this is the case a motor pump will be found much more economical than either an injector or a steam pump. The average small steam pump, such as would be used for the above purpose, has at full load a $\frac{\text{B.H.P.}}{\text{I.H.P.}}$ efficiency of somewhere about 22 per cent., and besides this waste in the pump must be reckoned the losses in the steam piping, which are considerable if it is of any length, as will probably be the case. A pump for this purpose will always be run at full load and constant speed, and these, being the ideal conditions for an electrically-driven pump, render competition in efficiency practically out of the question.

With feed, circulating, or air pumps, the conditions are somewhat different, in that they are larger, run over longer hours, and at various loads. The first reason, to a certain extent, does away with objection to steam piping, as the condensation loss falls proportionately with the size of the pipe; that is to say, the small pipes that would be used for the ordinary donkey pump, are proportionately much more wasteful than those that would be used with larger plant; also, owing to longer running hours, the loss occasioned by opening out the pipe range is proportionately less.

For large sets it is usual to instal a separate condensing plant with each, consisting of a condenser and air pump. Practice, however, differs as to whether each engine should have its own circulating pump. The present tendency appears to be in this latter direction, and probably it affords a more efficient and more easily worked arrangement; but in some of the older stations, where small sets and a common condensing plant were originally installed, it has been thought desirable to increase the size or number of the circulating pumps upon the advent of large extension sets. No doubt the cost and difficulties of installing large suction pipe work have been chiefly responsible for this, as otherwise there does not seem to be any advantage in it beyond that of centralisation of plant.

The question now arises, should these pumps be steam or electrically driven? and from the point of view of efficiency, the answer is certainly, electrically. Leaving the question of condensation losses in pipes out of it, and taking lbs. of steam per B.H.P.-hour as a basis of comparison, the electric motor is a more efficient generator of mechanical power than the small auxiliary steam engine.

Mr. Faraday Proctor in his interesting paper on the electric lighting system at Bristol, read before the British Association for the Advancement of Science in September, 1898, compares the efficiency of two 12-in. centrifugal circulating pumps, the one being steam driven and the other electrically; and, as their full-load result, gives 90·6 lbs. of steam per B.H.P.-hour for the steam pump, and 48·26 lbs. per B.H.P.-hour for the motor pump, that is, practically twice the efficiency. No doubt since these tests were carried out, improvements have been made in steam auxiliary plant, but where such a wide difference exists, it is hopeless to expect anything approaching to equal results.

It should be noted that in the above tests the steam circulating pump was driven by a compound condensing engine, not one of the wasteful single-cylinder type.

For circulating pumps, which are usually of the centrifugal type, the electric motor is particularly suitable, as it allows of direct coupling, and, owing to its high speed, takes up small floor space. The introduction of gearing of some sort that is necessary when motors are used for driving air-pumps, of course means an extra loss, but not one that appreciably interferes with efficiency.

The crusade against inefficient auxiliaries has been particularly strong in the direction of boiler feed pumps, and it was, no doubt, their great wastefulness that brought

the electric motor to the fore for this purpose. Although, perhaps, scoring on the point of efficiency over even the best steam feed pumps, there are many objections to the use of motor pumps for boiler feed, the chief being difficulty of efficiently regulating the supply of water.

The following methods have been used both severally and conjointly: Series resistance, shunt resistance, series parallel control, bye-pass to pump, cutting out plungers in multi-throw pumps, variable gears. The series resistance is out of the question, being extremely wasteful, and sure to more than nullify any economy over steam pumps. The shunt resistance does not give a very wide range, is apt to cause bad sparking, and in many cases has been found quite insufficient by itself; both the above methods also are objectionable, as they decrease the torque of the motor. Series-parallel control is of course efficient, and capable of a very wide range, but necessitating as it does two windings on the armature, two commutators and a controller, is expensive, not to mention complicated. The use of a bye-pass on the delivery side is very wasteful, being much on the same basis as the series resistance in this respect, and where relief valves are used for a bye-pass, it must be remembered that, besides the fact that all work done by the pump on the bye-pass water is wasted, it has to generate a higher pressure than is needful for the boiler feed in order to lift the valves. The cutting out of plungers in three-throw pumps on the suction side is efficient, but much too coarse to be of any great service; it also is apt to cause rather dangerous water hammer and straining in the delivery pipes if the pump is of any size, and fans the whole set by its uneven action. Variable gearing again does not give a wide enough range and is noisy, to a certain extent wasteful, and altogether a nuisance. It is obvious that the series-parallel control is the best system, but it cannot be said that it compares favourably with the simple operation of opening or closing a steam valve, which is all that is necessary in a steam pump. Taking everything into consideration, it appears that the best method is to install both steam and motor pumps. The latter should do the bulk of the work on heavy load, and should be kept running at constant speed and as near full load as possible, while the steam pump should be used simply for the small regulations that are constantly necessary, and for very light load. The installation of both sorts of pumps is also advisable as a safe-guard against breakdown of the steam or electric service. Feed pumps being such important items in the safety of a station, it is really necessary that some such precaution as this should be taken.

Injectors.—The objections against injectors for boiler-feeding are insufficient range, and therefore erratic steam pressure, inability to work reliably when supplied with water at a temperature of over 105° F., and rather lower efficiency than an ordinary steam pump, except when using cold water. It is upon this latter point that the value of an injector turns. In the case of a very small station where very low capital cost is necessary, the injector may be fitly installed, as it does away with the necessity of a feed heater.

Injectors are popularly supposed to be unreliable and erratic in their action; and certainly it takes only a very little thing, such as dirt, in the valves to upset them. There can, however, be no doubt that with care and an occasional overhaul, which is not a big matter, they are as reliable as any pump, as a proof of which may be instanced their almost exclusive use on locomotives. It is unlikely that they will ever be used for large work, and, indeed, they are not fitted for it, but as stated above, in small stations where capital economy is essential, they may be recommended.

Stoking and Economiser Gear.—As with pumps, motor-driven stoking gear is decidedly the most efficient, and as variation of speed is not required to any extent, electrical driving is certainly to be recommended. Owing, however, to the always present possibility of a breakdown in the supply, it is, as with feed pumps, scarcely judicious to rely on the one kind of power solely for such an important part of the plant. It is, of course, always necessary to duplicate the stoking machinery, and it would appear that the safest and most economical results may be obtained by using both sources of power in equal proportions, the steam plant being looked upon chiefly as a stand-by.

When possible, it is best, being cheapest, to drive economiser scraping gear from the stoker plant; but if the latter is not installed, or is too distant, motors alone should be used, as the steady load at constant speed allows them to run under excellent conditions.

Source of Power.—The single-phase alternating current station is, by its system, greatly debarred from participating in the benefits of electrical power for driving its auxiliaries. Unfortunately, the single-phase motor is comparatively unsuitable for this kind of work. It may be used for economiser scrapers or circulating water pumps, but it is doubtful if it is fit for anything beyond these.

This being the case, some engineers have gone so far in the pursuit of economy as to drive the auxiliary plant by direct current motors supplied from the exciter circuit. While, no doubt, gaining in efficiency by this method, the risks attendant upon it are very liable to cause that efficiency to be bought at too great a price, viz., that of inconvenience in working, or perhaps failure of supply. In good design, the exciter circuit of an alternating current station is always absolutely inviolable, because the slightest interruption or unsteadiness of the exciting current will often lead to complications when alternators are in parallel. It follows that the carrying of loads from this circuit into all sorts of out-of-the-way places is alone highly dangerous, and when to this is added the use or misuse of starting switches by inexperienced men, the policy is obviously bad. Besides the above objections, the low voltage of most exciter circuits makes the installation of motors exceedingly costly.

Distribution of Power.—The distribution of power to the various motors should be done in a systematic manner by special mains fed from a special distributing board, and, in order to keep a check on the consumption and encourage economy, it is advisable that the several circuits should each be metered, readings being taken daily. It is here that electrical driving stands out so favourably in comparison with steam; there is no possible method of keeping a check on the consumption of the latter, while with the former it can be carried to a very fine degree. The average stoker or engineman, however careful he may be with his firing or driving, cannot appreciate that these small engines take enough steam to be worth troubling about, and consequently adds to their inherent wastefulness by neglecting even ordinary economical precautions.

Considering that auxiliary plant is always under the control of men who are more or less ignorant of electrical matters, it should be very carefully protected by efficient circuit-breakers and good starting switches, which should, of course, if possible, be placed out of the way of dirt and damp, and should be selected from those designs which show a minimum of bare live parts.

ELECTRIC PUMPING FOR IRRIGATION.

By E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E.

Amongst the most interesting electrical installations in that very up-to-date country, California, is the irrigation pumping plant at Bakersfield. The climate is too dry to make farming practicable without irrigation, and for a great portion of the year there is no surface water flowing in the Kern River or its branches, as it is all taken off for irrigation soon after it comes down from the mountains. This leaves the greater portion of the valley without water, except such as can be pumped.

Upon investigation it was found that there was a plentiful supply underground which could be reached by wells 60 ft. deep, and by sinking wells into this a considerable area of country has been irrigated. A 30-H.P. set will pump enough water to irrigate 1 sq. mile of land, the average total lift of water from the well to the surface being about 25 ft.; the pumps raise from 3½ to 5 cb. ft. of water per second, the delivery being a 10-in. diameter galvanised steel pipe.

The pumps are all of the centrifugal type, and the problem of driving them has been solved by electric transmission of power, a water-power plant being established on the Kern River in the mountains, and three-phase current transmitted at 10,000 volts to numerous electric

pumps, 13 miles away. Each pumping station contains two step-down 15-KW. transformers, 10,000/500 volts, an outdoor switch worked by ropes for cutting off the 10,000-volt supply, and a 30-H.P. three-phase motor mounted on a vertical shaft, at the bottom end of which (and 15 to 20 ft. below the surface), there is a centrifugal pump. This construction has been adopted because it is important to have the pump as near the water as possible.

With a horizontal shaft, the electric motor must necessarily be placed above the high-water line with the pump stopped. Now as the water falls away a number of feet directly the pump starts, this means that on a horizontal shaft it must work with considerable suction, and hence inefficiently, probably under 50 per cent. The tests made with the vertical shaft pump show an efficiency of 67 per cent.

As the mounting of the motor on a vertical shaft is somewhat novel, it may be of interest to mention that the end thrust due to the weight is almost entirely counter-balanced by pressure upwards due to the suction entering on the top of the pump casing. Such as it is the thrust bearing is at the top of the motor, and the oiling is taken care of by making the motor shaft hollow. The oil runs through the bearings into a receptacle below the motor, and is picked up by a scoop on the shaft which forces it, by virtue of the speed of the scoop, upwards, through the shaft and into the bearing again.

In case the suction should fail owing to temporary stoppage due to interrupted current supply, the motor is switched out of circuit by means of an automatic device dependent on the water pressure in the pump. This ensures that the pump shall not stop every time the voltage drops slightly, by reason of a short circuit on the line or from other cause.

In each pump pit there is a small piston pump, which can be belted to the motor shaft for priming purposes.

In operation one man attends to eight or ten wells. The pumps run continuously, and each is visited by the attendant twice a day. There is a telephone to each pump house. The load for pumping and other ranch purposes is about full load for two 750-KW. generators, and the power factor is about 75 per cent.

Most readers will appreciate the advantages of the above-described method of irrigation as compared with that usually adopted of cutting long canals, and possibly emptying some river.

One great advantage is that the water is lifted exactly at the spot where it is required, and does not have to be brought by long and expensive water-courses over other ground, which is probably already well watered.

In any case there are many places where no surface water is available, and in such, recourse must be had to wells. It is interesting to note that as a prevention against drought 715 artesian wells have been sunk in Queensland alone, and nearly 200 million gallons are pumped daily. As a consequence, large tracts of country, which used to be waterless deserts, have come under cultivation, and support immense numbers of cattle and sheep without any risk of their destruction by prolonged drought. Of course, this has only been done by large expenditure, the Government alone having advanced over a million sterling. When, however, the whole secret of existence in such places is water, and plenty of it, the money is well spent.

In India, the irrigation question is all important, and so far it has been met by canals. This is a tedious method, and it is just a question whether it would not be wise to try artesian wells along with a well-considered scheme of electric transmission from central power stations. For the deep wells, three-throw ram pumps would, of course, take the place of the centrifugal pumps, the depth at which to employ the ram type depending on circumstances. Very high lifts can, as a matter of fact, be dealt with by centrifugal pumps by the exceedingly simple method of putting two or more on the same shaft and pumping from one to the other in series. After all, however, this is a matter of engineering detail, which does not affect the broad question of the simplicity and economy of irrigating large areas by means of numerous small electrically-driven well pumps, as has been carried out so successfully in California. Cutting canals for miles across open country is not the be all and end all of the irrigation problem, as some people would have us believe.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Sept. 23rd, 1902.			Week ending Sept. 22nd, 1903.		
Alexandria		Value £248	Alexandria		Value £78
Amsterdam		110	Amsterdam		100
Antwerp		83	Antwerp		95
Auckland		150	Auckland		131
Bangkok		29	Bangkok		141
Bombay		214	Buenos Ayres. Teleg. mat.		240
Buenos Ayres. Teleg. mat.		34	,, Teleph. cable		180
,, Teleph. cable		550	Calcutta		494
Calcutta		376	,, Teleg. wire		1,350
Cape Town		264	Cape Town		318
Channel Islands		20	Colombo		23
Christiania. Teleg. wire		23	Durban		1,208
Colombo		145	,, Electric cable		1,473
Copenhagen		75	East London		75
,, Teleg. wire		113	Fremantle		23
Delagoa Bay		40	Hamburg		26
,, Teleg. mat.		841	,, Teleg. mat.		355
Durban		792	Hobart		85
Ghent		10	Hong Kong		25
Lisbon		55	Malta. Teleg. instruments		140
Madras		352	Melbourne		200
Malta		15	Montreal		177
Nagasaki		21	Oporto. Elec. cable		725
North Atlantic. Teleg. cable		2,180	,, Teleph. mat.		45
Ostend		40	Perth		37
Perth		298	Port Elizabeth		470
Port Elizabeth		210	Rangoon		18
Stockholm. Teleg. wire		94	Rosario		99
Wellington		198	Rotterdam		15
			,, Teleg. wire		12
			St. John's, N.F.		53
			St. Petersburg		300
			Shanghai		52
			Singapore		320
			Spegia		363
			Stockholm		33
			,, Teleg wire		22
			Suez		10
			Sydney		530
			,, Elec. cable		2,980
Total	£7,581		Total	£12,958	

Foreign Goods Transhipped.

Auckland. Elec. goods		Value £200	Barbadoes. Teleph. mat.		Value £24
Sydney. Elec. lamps		100	Madras. Elec. appar.		11
			Melbourne. Elec. appar.		19
			Sydney. Elec. lamps		300
Total	£300		Total	£354	

Swiss Turbines of 45,000 h.p. for Mexico.—Some important contracts have just been placed for various equipments to be installed in the huge hydraulic plant now under construction at Necaxa, State of Puebla, Mexico, by the Mexican Light and Power Co., Ltd., of which concern F. S. Pearson, consulting engineer of the Metropolitan Street Railway, New York, is one of the leading spirits. The initial capacity of the plant which, in the first instance, is to generate power for transmission to Mexico City, some 90 miles distant, will be 45,000 H.P. Ultimately the plant will be capable of generating 80,000 H.P. The turbines now ordered will be six in number and of 7,500 H.P. capacity each. The Swiss engineering firm of Escher, Wyss & Co., of Zurich, secured the contract. Their bid was some $20,000 less than that submitted by American concerns competing. The Riter-Conley Manufacturing Co., of Pittsburg, has been awarded a contract for 1,800 tons of steel pipe varying from 48 in. to 51 in. in diameter. The contract for the generators, which will call for six machines of 5,000 KW. each, will be let early next month through the New York offices of the company in the Columbia Building, 29, Broadway.—*New York Electrical World and Engineer.*

Electric Lift Controller.—The Lift Accessories Co., of Standard Works, Rolt Street, Deptford, are introducing a new patent electric lift controller, which is claimed to combine all the best features of their old Standard controller, and to be a reversing and new quick-break switch, with new automatic cutting-out attachment, and an automatic no-load and over-load return. With this controller it is said to be impossible to burn out the armature of any motor, and the resistance cannot be cut out without the armature moving. The firm make a speciality of patent single, two and three-phase alternating current automatic controllers, and they are also makers of push button attachments for lifts, trip switches, slack cable switches, hydraulic valves, and hand power gears.

Electric Fittings in Natal.—The value of the imports of electrical fittings into Natal during the six months ending with June last amounted to £43,000, as compared with only £24,000 in the first half of 1902.

Germany.—The report of the Deutsche Kabelwerke Gesellschaft, of Berlin, for the last financial year shows a gross profit of £12,292, as against a loss of £7,067 in the preceding 12 months.

British Exports of Electrical Machinery.—The exports of British electrical machinery are being maintained at a steady rate, the shipments during August amounting to £37,046, bringing up the total for the first eight months of the year to £295,853.

Dynamo Brushes in America.—The U.S. Customs authorities have given a decision to the effect that dynamo brushes, made of metal and used for collecting and transmitting electric currents, are not dutiable under the provision of the tariff for "brushes of all kinds," but are dutiable under the provisions of Paragraph 193 as "manufactures of metal" at the rate of 45 per cent. *ad valorem*.

Lectures.—Special courses of lectures on various engineering and electrical subjects are now commencing at the Royal Technical Institute, Salford, and some particulars will be found in our advertisement pages to-day.

Football.—In our issue for May 22nd last we referred to the contests between the Glover and Chloride football teams. As there were certain controversial points between the rival parties, we suggested that they should fight it out on the field and settle their differences. This, we learn, has now been done; the two teams (the winners of the Broughton and Swinton competitions) met on the Broughton ground on 9th inst. The game terminated with Glover's Cable Works the possessors of the coveted title of Electrical Rugby Champions, by two tries to one.

New Book.—Messrs. Whittaker & Co., of Paternoster Square, will in a week or two publish Volume II. of "Electric Lighting and Power Distribution," by Mr. W. Perren Maycock, M.I.E.E.

Auction Sale.—On Thursday, October 1st, Messrs. P. Huddleston & Co. will sell by auction a considerable quantity of electrical apparatus, of which some particulars are given among our advertisements to-day.

Catalogues and Lists.—The Union Electric Co., of Queen Victoria Street, E.C., has sent us a copy of its new illustrated price-list of "Union" monophase and polyphase motors; the list covers a range of small machines of ordinary speeds, suitable for everyday industrial uses. The machines are supplied both with and without slip rings, and short-circuiting devices; the starting is claimed to be simple, and the rotors are so constructed as to carry a considerable overload without falling out of step.

A price-list of their new standard V.I.R. flexible wire has been issued by Messrs. Johnson & Phillips.

Messrs. Holden & Brooke, Ltd., of West Gorton, Manchester, have just brought out several new lists. No. 43 deals with their exhaust feed-water heaters; No. 51 with expulsor pulsating pumps; No. 52 with exhaust heads, valves, fittings, &c.; No. 54 with silent heaters and thermo-regulators; No. 55 with Sirius steam traps; and No. 57 with split cone injectors and motor-car injectors.

We have received from the General Electric Co., Ltd., a copy of their new pamphlet dealing with the Aron electricity meter, which, as is well known, has been passed by the Board of Trade for use on both continuous and alternating currents. One of the principal advantages claimed for it is that it is a true watt-hour meter, and records direct in Board of Trade units. Further claims put forward for it are that it is capable of recording the smallest possible loads; it requires no starting current, the influence of any current, however small, being recorded on the dials. Another new pamphlet, No. M. 1,041, received from the same company, gives particulars of Milner's patent speed indicator, which is so made as to be capable of running accurately in either direction without any additional adjustment. It is recommended to the special notice of electrical, mechanical and central station engineers, &c., because of its extreme simplicity, which prevents it from getting out of order.

"Let Bygones be Bygones."—Our readers will remember that some little time back Messrs. W. T. Glover & Co., Ltd., hit upon the novel idea of publishing an electrical calendar with a quotation of more or less electrical interest on each day's slip. Some of the quotations have been delved from the records of speeches made in a bygone age, and therefore cannot fairly be applied to the prevailing state of electrical science and engineering. However, that fact notwithstanding, we believe that the calendar has had a continued popularity, and adorns the office walls of many a consulting engineer's office. It is, we suppose, because of this popularity that we are asked to say that a statement made years ago by Colonel Crompton respecting insulating materials, cannot, with justice be applied to a material which is comparatively new to the market. The Colonel said that nearly all insulating materials were then deficient in mechanical strength; did not retain their form through any considerable range of temperature; were readily damaged by oil and grease; and did not lend themselves to being cut and shaped by ordinary tools. We are asked to say that none of these strictures can be justly applied to Psychiloid, an electrical insulating material, which is being largely supplied by Psychiloid, Ltd., of Bridge Street and Love Street, Sheffield. Perhaps we may add that if other present day manufacturers of insulating materials feel that they are in any way wronged by the unearthed statement, they should take consolation and comfort from the "*nearly all*," and thank heaven that they are not as other manufacturers are. We most fervently pray that if any readers wish to make any corrections in the poetical and other effusions which are sandwiched between the hard dry facts on this interesting calendar, they will address them to the offices that we left some years ago.

Books Received.—"Electricity and Magnetism," by R. T. Glazebrook, F.R.S. Cambridge: The University Press. 1903. 7s. 6d.

"Conduction of Electricity through Gases," by J. J. Thomson, LL.D., F.R.S. Cambridge: The University Press. 1903. 16s.

"The Slide Rule," by C. N. Pickworth. 8th edition. Manchester: Emmott & Co., Ltd.

Trade Announcements.—The Electric Tramway Equipment Co., have removed from 138-40, Conybere Street, to 89, Glover Street, Birmingham.

Messrs. Schoen Bros., importers of, and agents for, electrical accessories, have removed from Lillie Road, S.W., to larger premises at 29, Cock Lane, Snow Hill, E.C.

Messrs. Carson & Evans are removing from 42, Finsbury Square, E.C., to 3, Fenchurch Buildings, E.C.

Fire Exhibition Awards.—The following are some of exhibitors who have been successful in securing awards at the International Fire Exhibition at Earl's Court:—

General Electric Co., Ltd.	Gold Medal.
J. H. Heathman & Co.	Silver "
P. Hensel & Co.	Gold and Silver Medals.
May-Oatway Fire Appliances, Ltd.	Silver Medal.
National Telephone Co.	Gold "
Pearson Fire Alarm, Ltd....	Gold "
Siemens Electrical Appliances Co. ...	Two Gold Medals.
Siemens & Halske...	Gold Medal.
Simplex Steel Conduit Co.	Gold "
Bergmann Electrical Works	Bronze "
James Pitkin & Co.	Gold "

For Sale.—The directors of the Savoy Hotel, London, are offering their complete electric lighting plant for sale. See our advertisement pages to-day.

Condensing Plant.—Messrs. Thornton & Crebbin, of Bradford, have just secured a second order for central condensing plant from the Ebbw Vale Steel, Iron and Coal Co., Ltd., Ebbw Vale, Mon. The first plant, which is now near completion, is of the surface condenser type, with dry and wet air pumps, circulating pump and engine and cooling tower, for dealing with 80,000 lbs. of exhaust steam per hour from the blast engine, electric generators and auxiliaries. The second plant is of the barometic type for dealing with 200,000 lbs. of exhaust steam per hour from the various engines of the steel works, and is also complete with air and circulating pumps, and two large cooling towers. The sizes of the plants may be better understood when expressed by horse power as follows:—The surface condensing plant deals with steam from engines equivalent to 6,000 H.P., and the barometric plant from engines of 15,000 H.P. These orders have in each case been secured in competition with Continental firms.

Dissolutions and Liquidations.—A meeting of the Anderson Electrical Traction Syndicate is to be held at Bradford on October 26th to hear an account of the liquidation proceedings.

A meeting of the Aluminium Supply Co. for a similar purpose is to be held in London on October 23rd.

The North-Eastern Telephone Co. meets at Gateshead on October 22nd, when Mr. C. Humble, liquidator, will report respecting the winding up.

In the Vacation Court on September 16th, in the case of Wilson *v.* Easton & Co., Ltd., counsel applied for the appointment of a receiver and manager of the company's business, with liberty to borrow £1,500 to pay wages, in order to carry on the business. Plaintiff was a debenture holder, and the London Trust Co. was the trustee for the holders of debenture stock. The business was that of manufacturers of lifts for tube railways. Mr. Draper, for the company, said he could not consent to the order asked for, nor could he resist it. After hearing Mr. Bramwell Davis, K.C., for Captain Johnson, who had advanced the company money, his Lordship made the order substantially as asked, and directed counsel to endorse the terms of it on their briefs. Mr. W. B. Peat has since sent out a circular relating to the company; he is acting as receiver and manager and carrying on the business under the sanction of the Court. He will be responsible for all goods ordered after September 16th.

Messrs. J. Elias and E. E. Adamson (A. E. Gaskell & Co., machinery and soft goods merchants and manufacturers, 6, Dickinson Street, Manchester) have dissolved partnership. Mr. Elias will continue the soft goods business under the old style, but Mr. Adamson will continue the machinery department as Adamson Bros. & Co.

ELECTRIC LIGHT AND POWER NOTES.

Aberdeen.—The Corporation has fixed the following charges for electricity for the year 1903—1904:—For lighting: For the first hour daily of the maximum demand, 6d. per Board of Trade unit; thereafter, 2½d. per Board of Trade unit. For motive power: For the first hour daily of the maximum demand, 3d. per Board of Trade unit; thereafter, 1d. per Board of Trade unit. Minimum charge per half-year: For lighting, £1; for motive power, 10s.

Aston.—The electric generating station in Chester Street is now completed, and the District Council is in a position to supply electricity for all purposes. The station has cost £62,000. The formal opening of the station will take place on the 29th inst.

Barnsley.—The T.C. has decided to erect 10 arc lamps in Sheffield Road at a cost of £117. They will replace gas lamps.

Barry.—Some three years ago a provisional order was granted to the U.D.C. to supply electrical power within its own area. Up to the present the Council has not taken advantage of the provisional order, which will expire at the close of the present year. It is the Council's intention, however, to apply to the Board of Trade for an extension of the order, and it is now considering the terms submitted both by the South Wales Co. and also by a London company for the supply of electricity. The question has been referred to the Parliamentary Committee of the Council, whose report was recently considered, and it was intimated that a deputation had been appointed to wait upon the directors of the South Wales Electrical Power Co. at a meeting to be held at Cardiff.

Bideford.—Messrs. Willey & Co., of Exeter, have proposed, in the event of the Council deciding to instal the electric light in the town, that they should be allowed to lay propositions before the Council when the latter has obtained a prov. order.

Boston.—At a meeting of the Town Council last week it was decided to appoint an electrical engineer to prepare, construct and work a scheme for the electric lighting of the town on the lines of the present provisional order. At a previous meeting it was decided to temporarily light the new municipal buildings with gas. This resolution was now rescinded, and it was resolved to light the buildings by electricity, at an estimated cost of £480.

Boston, U.S.A.—A new electric light station, operated by steam turbines, will shortly be erected by the Edison Electric Illuminating Co., and, when completed, the ultimate equipment will be equal to an engine capacity of 96,000 H.P., and an electrical capacity of 60,000 KW., in 12 units, which, together with the 9,000 KW. already installed in the old station, will provide a total of 69,000 KW. or 92,000 H.P.

Bulawayo.—The Electric Light Concession, which is worked by the Bulawayo Waterworks Co., who are now before the British investor with an issue of £60,000—6 per cent. debentures, was granted in February, 1895, subject to a similar right of expropriation on and after February 28th, 1920. The plant is of a capacity of 380 KW., and can be at any time augmented as required at no great additional cost. It is expected that excellent coal from Wankies will be obtainable before the end of the present year, and this is estimated to bring about a considerable reduction in the cost of electric generation. All the plant is kept in good repair and is in thorough working order. The electric light mains are laid throughout the town and suburban township for a total length of 80 miles. The electricity is sold on a sliding scale, from 1s. 10d. to 2s. per unit; to public offices or charitable purposes at 1s. 7d.; and for street lighting at 1s. 5d. per unit.

Carnarvon.—A special meeting of the T.C., convened for the purpose of pushing the proposed electric lighting scheme one step further towards completion, was recently held. The circumstances are somewhat peculiar. The Council has entered into a provisional agreement with the National Electric Wiring Co. for an electric installation at Carnarvon, the Corporation under the agreement providing the necessary capital to the extent of £17,000, and the company undertaking to construct the works and to maintain them for a period of years, repaying the Corporation the annual instalments of principal and interest on the loan, together with all profits over and above a specified amount secured to the company. Since the Corporation made this provisional agreement, another company—the North Wales Power and Traction Co., Ltd.—appeared on the scene with an offer which, it was alleged, would reduce the expenditure by the Corporation from £17,000 to £8,000, while also offering other alleged advantages. The local inquiry by the L.G.B. has been fixed for September 22nd.

Mr. John Pritchard, chairman of the Electric Lighting Committee, brought up a special report from that body, recommending the Council to adhere to the arrangement already provisionally made with the National Electric Wiring Co., with a supplementary agreement under which the company would undertake free wiring for consumers, on certain specified terms, the Corporation, under that agreement, binding itself when taking over the concern to pay the company a sum of 16s. 6d. per lamp less 2½ per cent. per annum deducted for depreciation.

A long and highly technical discussion followed.

Councillor J. T. Roberts proposed, and Alderman Hughes seconded, an amendment deleting the proposed arrangement for free wiring. The amendment was pressed to a division, and the voting proving equal for and against, the Mayor gave his casting vote against the amendment, which was consequently lost.

A further amendment to refer the wiring clause back to the Committee was agreed to. The Committee's report, with this clause omitted, was then agreed to.

Chippenham.—Mr. J. S. Enright has submitted to the T.C. a scheme for the electric lighting of the town. As a start, he recommends the provision of a small installation, at an estimated cost of £10,900, for private lighting he suggests a charge of 5d. per unit, and he recommends, without hesitation, that a prov. order should be applied for by the Corporation.

Coventry. — The Corporation E.L. Committee has decided that from October 1st consumers shall be allowed the option of paying for energy either by the present system or by a flat rate of 4¼d. per unit.

For motive purposes the price of energy up to a consumption of 2,500 units per quarter has been fixed at 1¾d. per unit, and beyond at 1d.

Dartford.—The U.D.C. has decided to extend the electric lighting mains to Great Queen Street, and to convert the present gas lamps into electric lamps at a cost of £225.

Dublin.—On Saturday evening last the Corporation's E.L. system was successfully changed over to the new Pigeon House station, and the Fleet Street station will in future be discontinued.

East Ham.—The electrical engineer of the U.D.C. suggests that the price of electricity for lighting purposes be reduced as follows:—On the demand system:—from 7d. and 2d. (as at present) to 6d. and 2d. per unit; alternative flat rate from 5½d. to 4½d. per unit; churches, chapels, and schools from 5d. to 4d. per unit. The matter will be considered at the next meeting.

Exeter.—The E.L. Committee reported that the electrical engineer had presented his second certificate, and that the sum of £9,335 was due to the British Westinghouse Electric Co. for work completed and materials delivered in connection with the contract for the erection of the new works.

Felixstowe.—The Council's consulting engineer, Mr. Wilson, has advised it to adopt steam in all future extensions of generating plant. Mr. Prentice, of the supply company, which runs the station, desired to perpetuate the gas plant, making extensions in the vertical multi-cylinder type. Mr. Wilson considered that the increased sizes of the engines favoured the adoption of steam.

We commend the Council's attention to the results achieved at Walthamstow, and given elsewhere in this issue, also to the progress of events at Redditch, where the use of a bituminous producer is recommended as a great saving.

Frome.—There is a prospect of the town being supplied with electricity ere long. The U.D.C. has passed plans for the erection of an electric light station by Edmundson's Corporation. The laying of cables is to be commenced forthwith.

Hanwell.—The Works Committee of the U.D.C. has under consideration the advisability of seeking an electric light provisional order.

Italy.—The Oerlikon Co. has in hand a power transmission installation for Bageline, in Italy, in which a pressure of 40,000 volts will be used—the first instance in Europe of so high a voltage being employed. The project is designed to distribute power to the town of Brescia and the neighbouring works, many of which are engaged in electro-chemical industries. Power will be derived from the river Caffaro, rising in the Tyrolean Alps, and feeding the Chiesa. Some 11,250 KW. will be available, divided between two works, of which the one under construction will develop 7,500 KW. The head race will be 4,500 m. in length, more than half of this being in tunnel; the quantity of water passed per second will be 4,000 litres, with a fall of 254 m. Three-phase current will be generated at 9,000 volts, 42 cycles per second, in alternators of 1,900 KW. each, and will be transformed up to 40,000 volts for distant transmission.

Japan.—Acting Consul John B. Rentiers, reporting on the trade of Nagasaki for the year 1902, refers to the rearrangement of the shipbuilding yard there, and he states that steam power in all parts of the works is rapidly being superseded by electricity and compressed air. The reason for this is the scarcity of water on that side of the harbour, which necessitates water being brought to the works by boat at an annual cost of £2,000.

The Lizard Light.—On October 1st the new revolving flash-light at this Cornish signalling station will replace the present two, each of 500,000 C.P. Twenty-six years ago these took the place of oil lamps. At present the only lighthouses fitted with electric illumination are those of the Lizard, Souter Point in the North Sea, the South Foreland, and St. Catherine's Point, Isle of Wight. At the Lizard station oil lamps are still retained for emergency purposes, but of much less penetrating power than the existing electric lamps, which are visible 25 miles. The new installation is being fitted in the east tower. This will have 1,000,000 C.P., and illuminating power covering a distance of between 40 and 50 miles. Every five seconds the flash will be visible. There is also to be a fixed light in line with the Lizard Head as a mark for mariners, who will thus in future be able to tell whether they are clear of that point. The alterations will entail an expenditure of over £3,000, but there will be a reduction in the number of lighthouse keepers, of whom at present there are six, in addition to an engineer.

Llandudno.—The Electric Lighting Committee submitted a statement of the revenue account of the electric lighting undertaking for the year ended March 31st last, from which it appeared that, after making provision for the repayment of loans and interest, there was a deficiency on the year's account of £368. The deficiency was provided for out of the balance of £427 which stood to the credit of the undertaking at the commencement of the financial year. Councillor T. W. Griffiths adversely criticised this statement. The chairman pointed out that the ratepayers had not yet been called upon to contribute a single penny towards the deficit on the working of the electricity department, and he thought they would not be called upon to do so.

London.—MARYLEBONE.—At the B.C. meeting the Town Clerk stated that efforts had been made to induce the Board of Trade to grant a licence constituting the Council an electric lighting authority, thus enabling it to complete the purchase under the arbitration award of the local undertaking of the Metropolitan Electric Supply Co. This step was necessary owing to the omission of certain words from the special Act of Parliament which the Council obtained. The absence of these words caused the London County Council to decline to sanction a loan for the purchase money amounting to over a million sterling. Failing the Board of Trade, recourse would be had to the Local Government Board. The Board of Trade was not prepared to grant a licence, but the Town Clerk did not regard this decision as final.

ST. PANCRAS.—The half-yearly estimates submitted at the B.C. meeting showed that the expenditure on public lighting for the six months ending March 31st, 1904, would be £14,212; £4,330 of this will be paid to the gas company for gas. The profits shown on the electricity undertaking, £7,220, are put down in the accounts to reduce the lighting estimate, and accordingly make it only £6,995 for the half-year.

Southwark.—On Wednesday the B.C. resolved to light with Nernst lamps, at a first cost of £60 and an annual charge of £187, certain side streets now fitted with incandescent electric lamps.

Mulhouse.—A project is on foot for the utilisation of the waters of the Rhine at Mulheim for the generation of electricity, which will be transmitted to the towns of Mulhouse and Fribourg, and the adjoining districts. About 15,000 H.P., it is estimated, will be available.

Newcastle-on-Tyne.—The City Council has decided to promote a Bill in Parliament for certain improvements to the quay, at a total cost of £599,000. The scheme involves an elaborate electrical equipment, estimated to cost £44,000.

Northfleet.—The U.D.C. at the last meeting discussed draft proposals by the Sir Hiram Maxim Electrical Engineering Co., Ltd., for carrying out the Council's provisional order. These proposals included a provision that the Council should obtain a loan for the capital expenditure required for the construction of works and the provision of plant, machinery, and mains, such works and plant, &c., being constructed and provided by the company in accordance with plans and specifications to be prepared by, and to be under the supervision of, the company's consulting engineer (Mr. F. J. Warden-Stevens, of Westminster). It was unanimously resolved to inform the company that the only form of agreement the Council would consider would be a contract for the execution and maintenance of the works authorised by the provisional order, the company to provide all the capital.

Penmaenmawr.—The U.D.C. has decided to call in an expert in connection with a proposed electricity supply scheme for the district.

Pembroke.—Recently a discussion took place at the D.C. meeting on an application for the extension of electric light cables at an estimated cost of £100. Several members opposed the expenditure, and a Mr. Ramsay thought that if the application were granted, other districts would also be wanting the electric light. Happily the enlightened views held by this member are not as yet universal, or we might be tempted to inquire what an electricity supply undertaking is for.

Plymouth.—Some discussion has occurred as to the advisability of lighting the asylum by electricity at a cost of £2,550, and the Asylum Committee has deferred the settlement of the question until the cost of gas lighting has been ascertained.

Portugal.—A contract has been entered into by the Municipality of Faro for the public and private lighting of the town by electricity.

Rhyl.—The U.D.C. has recommended that the charge for electricity supply to the Queen's Palace Syndicate should be raised from 3d. to 3½d. per unit, on a guarantee of 40,000 units consumption for the year.

Saffron Walden.—The T.C. has adopted the recommendation of the Committee that an application should be made to the Board of Trade in November for a prov. order, enabling the Corporation to supply electrical energy for both public and private purposes.

St. Albans.—The terms under which the Corporation propose to hand over their electric lighting order to the North Metropolitan Electric Supply Corporation were discussed at a recent meeting. Mr. E. Macgregor Duncan, consulting engineer, and a representative of the Electric Corporation were present. The terms are, with the exception of one or two minor details, agreed to, and the agreement will probably very shortly be prepared. The order was obtained in 1900, so that the Corporation has been nearly three years in coming to a definite agreement on the matter.

Salford.—The T.C. has asked for permission to borrow £34,443 for extensions to the Electricity Works plant, mains, &c., in place of an unused loan of £43,282 for feeding cables, section boxes, and electrical equipment of the tramways.

South Shields.—At the South Shields Petty Sessions on the 15th inst. a labourer named John Pratt, of Hebburn, was charged with stealing electricity. The Northern Counties Electricity Supply Co., Ltd., prosecuted. It appeared that electricity had been stolen by cutting the meter out of circuit. The mains foreman for the complainant company said that after several inspections of the meter he became suspicious and switched the supply off at the meter, when he discovered that the light continued. Examination showed that the current had been diverted so as not to pass through the meter, thus defrauding the company. The defendant pleaded guilty and was fined 40s. and costs.

Stirling.—The number of units generated during the year was 194,076 against 177,062 last year. The revenue from the sale of energy was £2,961, compared with £2,030. £1,981 has been placed to the interest and sinking fund. There is a debit balance on the year's working of £367, against £784 last year and £905 in 1901.

Wallasey.—The electricity works accounts show that the year's revenue was £14,328, and expenditure, including £500 for depreciation and renewals, £8,478, leaving a surplus of £5,849. Of this sum, £1,698 went in interest, and £1,784 in loan repayments, leaving a net profit of £2,366 in favour of the district fund account.

Sydney (N.S.W.).—Electricity supply has made rapid progress in this city. The largest plant is used for the operation of the tramways, and there are five private enterprises supplying various sections of the city. Two small plants are owned by the Public Works Department, who are building a new power station, and the City Council's electrical scheme which is being carried out at the present time will cost some £150,000. The following table is of interest in connection with the above:—

Station.	Kilowatts.	Horse-power.	Equiv. in 16-c.p. lamps.
City Council	1,500	2,500	25,000
Strand Co.	858	900	14,300
Empire Co.	400	550	8,000
Arcadia	250	400	3,700
George Adams	225	360	3,600
Oxford Co.	332	445	4,000
Government (two)	560	700	9,000
Tramway	8,000	10,000	140,000

Tiverton.—At a recent Town Council meeting Messrs. J. S. Enright, consulting engineer, and J. Siddalls, borough surveyor, reported that, in accordance with instructions, they had prepared plans and specifications for an electric lighting installation for Tiverton. In the specifications two schemes were described—Mr. Siddalls' and Mr. Enright's. The first (*a*) provided for two gas engines of 100 nominal H.P., 130 house services, mains to be laid in earthenware troughs filled in with compound; and Mr. Enright's (*b*) specified two engines of 125 nominal H.P., a travelling crane, the cost of 200 house connections, triple concentric armoured cables laid direct in the earth. The battery for (*b*) was 25 per cent. larger than the battery for scheme (*a*), but in other respects the schemes were alike. Eight tenders for each scheme were received as follow:—International Electric Engineering Co., (*a*) £8,682, (*b*) £9,683; Frank Suter & Co., Ltd., £9,010—£9,900; British Westinghouse Co., Ltd., £9,267—£10,335; Bruce Peebles & Co., Ltd., £9,461—£10,538; Johnson & Phillips, £9,638—£10,899; Cox-Walkers, £10,030—£11,461; Lea, Son & Co., £10,202—£11,306; Willey and Co., £10,236—£11,584. The lower tenders being in order, the first four alone were reported on. They were of opinion that Messrs. Suter's tender for scheme (*b*) should be accepted, viz., £9,990, to which would have to be added £1,000 for buildings and £650 engineering, &c.—total, £11,640. The matter was adjourned to a special meeting to be held before the next general monthly meeting.

Walsall.—The Electric Lighting Committee has received the sanction of the Local Government Board to the borrowing of £7,868, the balance of a loan of £23,900 for extensions, and it recommends the acceptance of tenders amounting to £1,424 for new plant.

ELECTRIC TRACTION NOTES.

Austria.—According to a recently published statistical statement, the total length of electric railways and tramways in Austria, which reached 254·78 km. at the end of 1900, reached in 1901, the figure of 364·54 km., an increase of 109·76 km., or 43·08 per cent. In 1901, 50·57 km. of new electric lines were laid, and 59·19 km. of horse tramways were converted into electric traction. The various lines are worked by 26 administrations, seven of the systems being worked by municipalities, viz., those of Vienna, Olmutz, Aussig, Brux, Pilsen, Prague and Lemberg.

Chesterfield.—The Tramways Committee has brought up an electric tramway scheme which is estimated to cost £86,808 eventually, the immediate sections figuring at £55,714. The plans, sections, estimates and all particulars have been worked out by the borough electrical engineer, Mr. R. C. Acland. The scheme received the approval of the Council some days ago, and Parliamentary powers are to be sought next session.

Finland.—Consul C. J. Cooke reports that an electric railway is to be built from St. Petersburg to Systerback, on the Finnish border; but a petition to the Finnish Government for its prolongation to Imatra has been refused. The Technical Society are considering the possibility of making use of the many cataracts and waterfalls, in which Finland is rich, for generating electric power for many purposes, and thereby making Finland practically independent of foreign coal.

Greenock.—The T.C. have approved of the plan of a new car proposed to be used in Greenock, subject to the tramway company reducing the height of the step from 15 in. to 11 in. The company are to be communicated with, requesting that the cars and points be put in proper order, so as to lessen the excessive noise made by the cars.

Liverpool.—On Sunday last a party of employés of the Birmingham Corporation tramways department inspected the Liverpool electric tramways system.

London.—Southwark.—At the B.C. meeting a letter was received from the engineers of the Baker Street and Waterloo Railway Co. stating that owing to the impossibility of getting a suitable site for an electric transformer, the company had decided not to proceed with the station and subways which it was proposed to construct under the roadway at the Elephant and Castle. It

was their intention to place the station upon private property which the company were empowered to acquire in the London Road. A letter was read from the Board of Trade to the effect that after careful consideration of the conditions which the B.C. wished to impose upon the L.C.C. in respect to the electrification of the additional tramways in the district, the Board had decided to unconditionally approve of the plans.

Wandsworth.—The B.C. has decided to ask the City and South London Railway Co. to extend their present line from Kennington through Brixton to Streatham Common.

On Saturday last many members of the Civil and Mechanical Engineers' Society paid a visit to the generating station of the County Council's South London tramways at Camberwell. The visitors were met on their arrival by Mr. Rider, electrical engineer to the Council, and by assistants representing Mr. Alfred Baker, the Council's tramway manager, and Dr. Kennedy, the consulting engineer.

West Ham.—At the Corporation meeting on Tuesday it was reported that of the £300,000 recently raised by loan £120,999 had been put to the credit of the tramway undertaking, and £113,255 to the credit of the electric lighting undertaking. Mr. Francis Eggington, of Liverpool, was appointed chief clerk in the tramway department. The electrical engineer was asked to confer with the borough engineer, and report upon the best means of making future transformer chambers waterproof. It was decided to apply to the B. of T. for a provisional order to construct a short line connecting Romford Road and Leytonstone Road. The chairman of the Lighting and Tramways Committee and the tramway manager were appointed to represent West Ham at the Municipal Tramways Association. A motion was adopted to ask the L.C.C. to expedite the electrification of the line between Bow Bridge and Aldgate, with a view to it being put in hand at the same time as the work between Stratford and Bow Bridge.

North Wales.—A map of the Flintshire electric tramways scheme, which has been issued by the promoters, shows that the line will start from Queen's Ferry, and run parallel to the Chester and Holyhead line to Bagillt, from which place it will proceed to Holywell. It will then proceed to Halkyn, and on to Northop, Mold, and Buckley. From here it will proceed to Queen's Ferry. The route will be circular, and about 26 miles in length. A branch line will be constructed from Flint to Northrop. The overhead trolley system will be adopted, and goods and passengers will be carried.

Paisley.—It was reported at the meeting of Paisley T.C. that Mr. Parshall, consulting electrical engineer, had stated that part of the lines of the new tramways would be open for traffic at the end of March next, and that the whole system would be opened in June of next year. The question as to the possibility of obtaining a supply of energy from Glasgow for driving the Paisley and district cars had been raised at a meeting of the T.C. Committee, where it was explained that while the proposal might be practicable for the portion of the line between Hawkhead Road and the Cross, it would not be so for the whole undertaking. With regard to the position of the lines in the streets, it was decided that the T.C. should appoint a Committee to take cognisance of the construction of the tramways within the burgh. The Glasgow tramway connection with Paisley would, it was stated, be opened about the end of the present month.

The price agreed on for the acquisition of the present horse tramway system has been paid by Mr. Murphy.

Portugal.—A project which has been presented by the Lisbon Railway Co. ("Companhia Carris de Ferro de Lisboa") for the construction of a new electric railway line in the city of Lisbon, is open for inspection in the office of the Inspector-General of Telegraphs and Electrical Works, Lisbon.

Spain.—It is reported that an English syndicate is promoting a scheme for the construction of a network of electric tramways in the Alicante district.

Swedish Railways.—The administration of the Swedish State Railways, in a letter addressed to the Government, has expressed its intention of adopting electrical traction throughout its system. It is, however, proposed beforehand to examine closely those railways at present worked by alternating currents, in order to elaborate subsequently a programme of electrical equipment by way of trial. At the same time calculations of detail will be made as to the paying qualities of the different sections of the system and the expense necessary to the installation of electric traction on these sections.

Woking.—A syndicate recently submitted to the U.D.C. a scheme for running a light electric railway from Bagshot to Woking Station, and for laying down electric tramways in Woking. The Council at the last meeting agreed to the light railway, but passed a motion that the tramways could not be approved unless the syndicate would widen the roads.

Wolverhampton.—As foreshadowed in the Electrical Review last week, the Town Council met on Monday for the purpose of confirming the decision arrived at in secret to take over the Lorain system of electric traction. Contrary to expectation, the town clerk read the following report—submitted to the Town Council in private—of the special sub-committee of the Tramway Committee, giving the result of their negotiations with the Lorain Steel Co.:—

To the members of Tramway Committee.

Report of the special sub-committee appointed to negotiate with the Lorain Steel Co., with a view to avoid arbitration.

Your sub-committee now beg to report thereon. They have had several interviews with Mr. Wetmore, involving long and careful consideration.

These have resulted in obtaining from the Lorain Steel Co. the terms to which they are prepared to agree, with a view to avoiding arbitration.

These are as follows:—

1. The Corporation shall pay in cash to the Lorain Steel Co. immediately after the acceptance of this proposal by the Lorain Steel Co. £22,000 on account of the amount due to them on April 17th, 1903, under the contract.

2. The Lorain Steel Co. shall forthwith after such payment has been made supply to the Corporation at Wolverhampton 1,000 large size top-plates with removable centres, and as soon as possible fix them to 1,000 of the existing granites in substitution for the existing top-plates; such 1,000 new top-plates to be supplied and fixed at the expense of the Lorain Steel Co.

3. The Lorain Steel Co., without charge to the Corporation, shall, in addition, deliver to the Corporation at Wolverhampton 4,000 new top-plates with removable centres, of which 2,500 shall be of the large size.

4. Upon delivery of the new top-plates as provided in Clauses 2 and 3 the Corporation shall pay to the Lorain Steel Co. in cash the balance of the amount due under the contract of July 26th, 1901.

As an alternative, Clause 3 may be as follows:—

The Lorain Steel Co., without charge to the Corporation, shall, in addition, deliver to the Corporation at Wolverhampton 5,000 removable wearing centre top-plates, of which 2,500 shall be of the large size, and the Corporation shall deliver to the Lorain Steel Co. on or before April 17th, 1905, 5,000 old top-plates in lots of not less than 1,000 at any one time.

The Lorain Co. point out that the matter has been under consideration so many months that they now require it to be definitely cleared up by September 15th. If it cannot be settled by that date the matter will immediately go to arbitration.

This report was signed by the chairman, Alderman Mander, who moved that the report of the Tramway Special Sub-Committee now submitted be approved and adopted, and that the terms Nos. 1, 2, 3 and 4 offered by the Lorain Co. contained in such report be accepted, and that resolution No. 285 of the Council, passed on May 20th last, be rescinded accordingly. This was seconded by Alderman Craddock, and, on a division, was carried by 23 votes against 15. When the question came up for confirmation on Monday, the electrical engineer, Mr. Shawfield, was asked whether the offer then before the Council was better than that before the members in May, when the Lorain system was rejected. The reply of the electrical engineer was that, in his opinion, the offer now before the Council was "not so good" as that in May. However, after further debate, the resolution to purchase was confirmed by 25 votes to 15. As a result, five members of the Tramway Committee, who were opponents of the Lorain system, announced their intention of resigning their seats on the Committee, and this they have since done.

Subsequently the Council considered the question of intercommunication with the outlying districts, on which matter a report was submitted from the Tramways Committee. They had obtained tenders for the construction of the permanent way and the various tracks on the Lorain system and the overhead system (as should be decided by the Council), and they presented to the Council what, in the opinion of the Committee, is the tender which should be be accepted, whatever system of electric traction is adopted. The contractor is Mr. Herbert Holloway, of Wolverhampton, and his tender is as follows:—

Route.	Lorain system.	Overhead system.
Dudley Road	.. £11,582 10 0	£11,247 6 8
Wednesfield Road ..	.. 7,482 1 6	7,276 18 0
Willenhall Road ..	.. 9,985 5 0	9,654 5 0
Waterloo Road ..	.. 9,086 0 0	8,807 7 6

With respect to the electrical equipment of the routes, the report stated that the Lorain system will cost £1,800 per mile of single track, being the amount for which the Lorain Steel Co., in pursuance of their contract of July 26th, 1901, will carry out further extensions, not exceeding 30 miles in all, if required; whilst equipment on the overhead system will, it is estimated by the electrical engineer, cost £856 per mile of single track. The lengths of the various routes measured as single track are as follows:—

	M.	F.	Ch.
Dudley Road	2	2	5·3
Wednesfield Road	1	3	8·2
Willenhall Road	2	1	0
Waterloo Road	1	6	8·5

The Committee, in conclusion, ask for the instructions of the Council as to the equipment of the remaining routes, and they add that they think it advisable to point out that considerable difficulty will be experienced in the equipment of the Canal Street and Stafford Road routes on the overhead system, owing to the fact that railway bridges span these routes at a height only barely sufficient for vehicular traffic. Further, if dual systems are adopted, it will be necessary either to build a new car-shed for the overhead lines, or, in order to utilise the existing car-shed for both systems, to equip Piper's Row, Bilston Street, and Cleveland Road with the overhead wires, in addition to the existing Lorain system, or else equip all cars used on the overhead system with skates and other apparatus for working on the Lorain system as well as the overhead system.

It should be added that at the Committee meeting at which this report was drawn up, only five members were present, these being (with the exception of the Mayor, who was one of the five present) strong supporters of the Lorain system, the members opposed to that system having previously intimated that they would retire from the Committee. As the result of a short discussion of the report by the Council, it was referred back for reconsideration by the reconstructed committee with instructions to give further details, and to place before the Council recommendations for their guidance. Alderman Mander raised the question whether it was absolutely necessary to have through cars to the outlying districts, and seemed to think that because people had to change 'buses in London, it would be no inconvenience to change cars at Wolverhampton boundary in order to get further on.

During the great Lorain controversy at Wolverhampton, the local papers have been seldom free from some gem of correspondence. Now that a settlement has been made, we must expect but few more, so we hasten to preserve one of the latest. It appeared in the *Express and Star*, of Wolverhampton, and reads as below:—

"Sir,—In order to keep up the continuity of my advocacy I crave again repetition of your kindness, through the agency of your paper, to appeal to your readers on this question.

"By a substantial majority of 23 against 16, I hope a conclusive decision has at last been attained. Look again, please, at the facts of the great controversy. Had we been beaten 'topsy-turveydom' would have been our merited title, and scorn and contumely would have been ours.

"As a Council, some time back, we decided to municipalise our trams. Almost two years have elapsed since the first Lorain tram was seen. Not a solitary accident has occurred as the direct result of electrocution. Scores have happened in the country directly attributable to the deadly, dangerous system of poles and overhead wires. Consider the appalling liability of the authorities in matters of compensation in townships where the ugly systems work, making townships look like huge factories and 'scurrifying' nature's lovely outlook, and proving death traps to the sweet features of youngsters.

"One accident was said to have occurred as a result of electric force in the ground. This I deny most positively.—Yours truly,

"Thomas G. Bevan.

"1, Shaw Road, Blakenhall."

Presumably Thomas G. Bevan is under the delusion that he believes what he writes, and that readers of his letters are willing to take his mere assertion for hall-marked, statistically upheld proof. We can hardly be blamed for having contracted a habit of thinking of Wolverhampton as inhabited by a majority of people of the same mental calibre as Mr. Bevan, although we know that in reality it is only the majority of 23 in the Council governing the people who feel like that. It would be a matter of intense interest to our readers if Mr. Bevan would send us a list of the "scores of accidents occurring as the direct result of electrocution" directly attributable to the deadly, dangerous system of poles and overhead wires. Reading "electrocution" and "deadly dangerous," we anticipate a roll of fatalities, of which, so far as we know, the coroners have not heard. From the last portion of the delightful sentence beginning "consider the appalling liability. . . ." we are inclined to believe that Mr. Bevan is introducing something novel in the way of ritual murders into the standard arguments (arguments and "Bevan" do not mix well) against the overhead system. "Positive denial" of anything from such source ought to be accepted implicitly, even when the fact denied has been vouched for by the borough electrical engineer.

TELEGRAPH AND TELEPHONE NOTES.

The Pacific Cable.—It is reported from Ottawa that Lord Strathcona has conferred with Sir W. Mulock, the Dominion Postmaster-General, with regard to the landline rates between Canada and Australia, which are said to be so high as to militate against the business of the Pacific cable. Sir W. Mulock was unable to promise relief, as the Government exercise only a nominal control over the rates of the telegraph lines.

Wireless Telegraphy in Russia.—According to the *Electrotechnik*, of St. Petersburg, trials of wireless telegraphy at short distances have been carried out by the military telegraph school at St. Petersburg with excellent results; so much so, that it is proposed to continue the trials between greater distances. In the course of 1902 communication was established between St. Petersburg, Cronstadt, and the Park of Ærostation, established behind Volkhov Cemetery. For future experiments it has been decided to adopt large poles bearing a regular system of wires, and to instal new stations at Narva and Gatchina. If the experiments during the current year give equally good results, an attempt will be made to organise a service of wireless communication between St. Petersburg and Warsaw, and other localities equally distant from the Russian capital.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—October 3rd. The Municipal Authorities of Liège are inviting tenders until October 3rd for the supply of six electric tramcars. Particulars may be obtained from, and tenders are to be sent to, Le Bureau Administratif des Travaux, à l'Annexe de l'Hotel de Ville, Liège.

Belgium.—The Belgian State Railway Authorities at La Bourse, Brussels, are at present inviting tenders for the supply of 205,000 metres of arc lamp carbons.

Brighton.—October 5th. Steel rails, tramcars, points and crossings for the Corporation tramways extensions. See "Official Notices" September 11th.

Brisbane.—September 30th. The Deputy Postmaster-General is in the market for certain postal and telegraphic material.

Cuba.—September 28th. Tenders are being invited until September 28th by the municipal authorities of Cienfugos for the concession for the electric lighting of the public streets and buildings of the town.

France.—October 1st. The French Post and Telegraph authorities in Paris are inviting tenders until October 1st, for the supply of a large quantity of paper-insulated electric cables. Particulars may be obtained from, and tenders are to be sent to, Le Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle 103, Paris.

Harrismith.—October 19th. Water-tube boilers, 25 and 80-kw. steam alternators, and other plant. See "Official Notices" to-day.

Holland.—October 1st. Tenders are being invited by the municipal authorities of Utrecht for the construction and equipment of a central electricity station for lighting and power purposes, and for the working of a tramway.

Italy.—September 28th. Tenders are being invited by the municipal authorities of Torremaggiore (Foggia) for the concession for the establishment and working during a period of 30 years of a central station in the town for public and private electric lighting purposes.

Johannesburg.—October 5th. A large quantity of steel rails, fishplates, tie-bars, &c., for the Corporation tramways. See "Official Notices" September 11th.

Johannesburg.—November 16th. Gas producer plant; gas engines and dynamos. Alternative:—Water-tube boilers, steam engines or turbines, electric generators, and other plant. For the municipal tramways and electrical supply scheme. See "Official Notices" August 28th.

King's Norton.—October 10th. Overhead construction for three miles of line. See "Official Notices" to-day.

Launceston (Tasmania).—September 28th. 500 or more electric meters. See "Official Notices" June 12th.

London.—October 6th. Four 5,000-H.P. vertical-horizontal steam engines, each suitable for driving a three-phase generator, for the Greenwich power station. See "Official Notices" July 24th.

Manchester.—October 1st. 1,200 electricity meters. See "Official Notices" September 18th.

Manchester.—October 5th. 30-ton electric lift for the electricity department. See "Official Notices" to-day.

Portugal.—October 21st. Tenders are being invited until October 21st by the Portuguese Ministry of the Colonies in Lisbon for the concession for the electric lighting of the town of Macao in the Portuguese Colonies.

Rochdale.—September 26th. Electrical work at the Dearnley Workhouse. See "Official Notices" September 4th.

Roumania.—October 10th. Tenders are being invited until October 10th by the Roumanian State Railway Authorities in Bucharest, for the installation of a complete electric lighting plant at the railway works in that city.

Salford.—October 19th. Sundry machinery for the Pembleton central car depôt. See "Official Notices" to-day.

Sheffield.—October 8th. 25 double-deck cars with trucks and equipments. See "Official Notices" September 18th.

Spain.—Tenders have just been invited for the concession for the electric lighting of the town of Villacarillo (province of Jaen) during a period of 20 years.

Swansea.—October 31st. Permanent way, rails, special work, overhead equipment, cables, ducts, &c., for tramways. See "Official Notices" to-day.

Swansea.—October 31st. Ducts, troughs, cables, wires, street boxes, &c. See "Official Notices" to-day.

Sweden.—October 15th. Tenders are being invited by the municipal authorities of Gelfe until October 15th for the supply of six electrical cranes.

(*Continued on page 508.*)

ELECTRICITY SUPPLY IN MILAN.

In our issue of July 24th last we described, amongst other hydro-electric power stations in Italy, that of Paderno, which is mainly engaged in transmitting power to Milan. The station contains seven 1,500-kw. generators, which are fully loaded for a great part of the day, and extensions are to be carried out shortly; the distribution of the huge output of the works is shown by the accompanying diagrams, for which we are indebted to the courtesy of Signor G. Semenza, the popular secretary of the Italian Electro-technical Association in Milan. The diagrams also show the output of the Porta Volta steam power station, which works in parallel with Paderno, and the relative amounts of energy used for lighting, traction, &c.

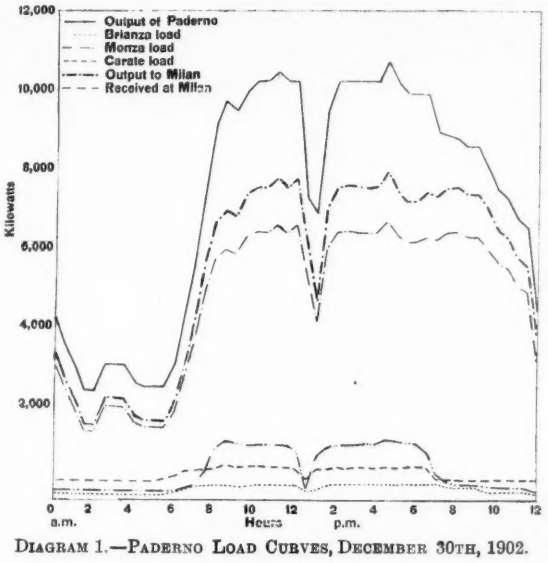


Diagram 1.—Paderno Load Curves, December 30th, 1902.

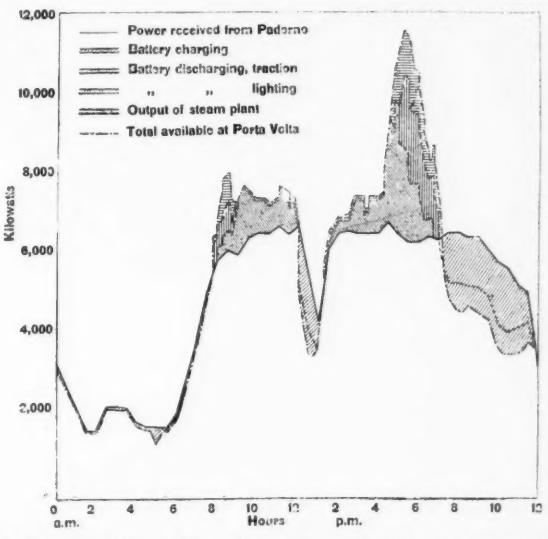
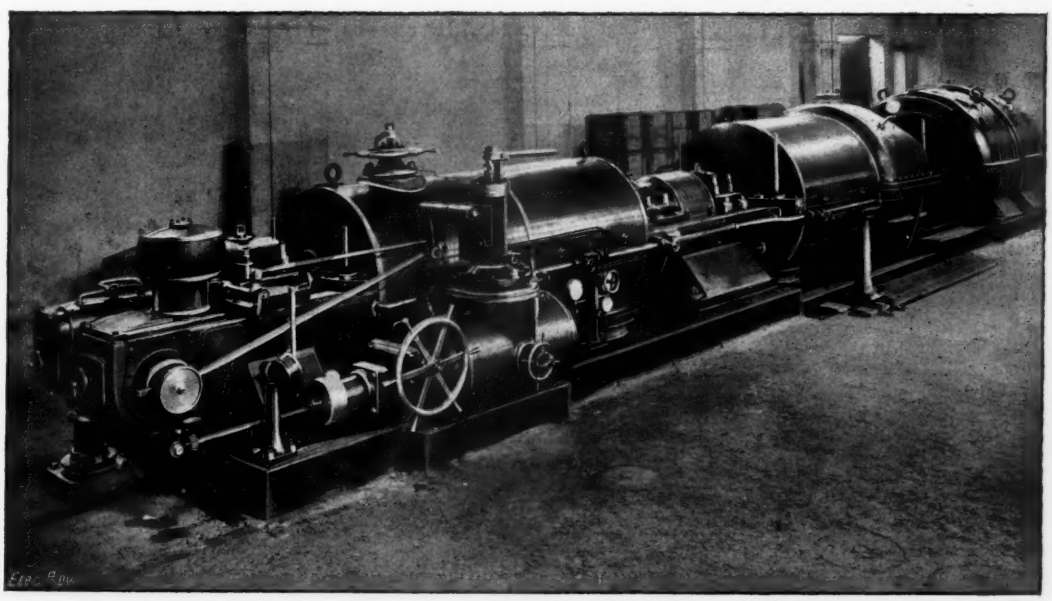


Diagram 2.—Porta Volta Load Curves, December 30th, 1902.

Diagram No. 1 shows the total output at Paderno, the power transmitted to and received at Milan, and the consumption at Brianza, Monza, and Carate respectively; the highest load on the day in question (December 30th, 1902) was 10,750 kw., and occurred at 4.30 p.m., but the load never fell below 3,300 kw. from 6 a.m. to 1 a.m. The load factor of the Paderno plant on this day works out at about 70 per cent., and as the load consists so largely of motive power, it will not fall off during the summer months anything like as much as that of a lighting station.

Diagram No. 2 shows how the power available at Porta Volta, including that received from Paderno, is disposed of. The shading corresponds with the index given on the diagram, the clear area representing the energy received from Paderno. It will be seen that the steam plant is run from 7.45 a.m. to 12 noon, and again from 1.15 to 7.15. During these times the load exceeded the power incoming from Paderno, though between 12 and 2 the usual drop occurs; the opportunity is utilised for charging the batteries. The latter are used to a considerable extent during the peak load, from 4.30 p.m. to 7, and are again charged from 7 till midnight. It is noteworthy that at the extreme height of the peak load the battery discharge reaches almost



Porta Volta Works, Milan: 4,500-h.p. Parsons-Brown Turbo-Alternator.

3,000 KW., a record rarely equalled. By the use of the battery the greatest benefit is derived from the water-power.

Diagram No. 3 shows how the total output of energy available at Porta Volta is utilised; it will be seen that the bulk of it is sent into the three-phase network, while traction calls for a large proportion, and direct current lighting and power calls for least of all. All the diagrams apply to the same day.

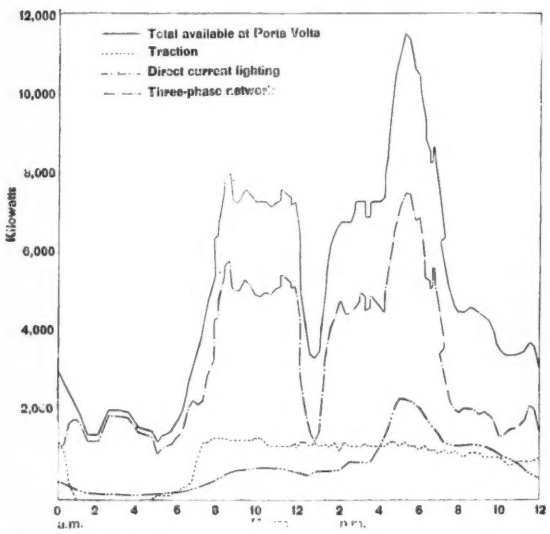


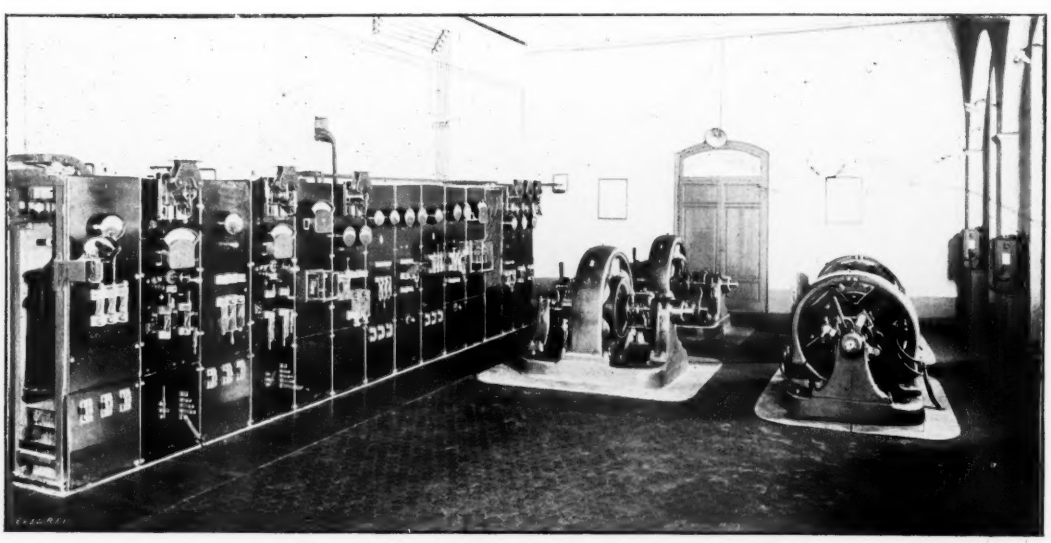
DIAGRAM 3.—PORTA VOLTA LOAD CURVES, DECEMBER 30TH, 1902.

We have on previous occasions described the plant installed at Porta Volta; we need only mention, therefore, that this station contains steam plant of a total rating of 13,000 H.P. All the generators were supplied by Messrs. Brown, Boveri & Co., of Baden; three of the engines were supplied by Messrs. Franco Tosi, and one by Messrs. Sulzer Bros. The most interesting sets are of more recent date, and are respectively a Parsons turbine of 3,000 H.P. coupled to a Brown alternator, and a Parsons-Brown turbo-alternator of 4,500 H.P. The latter is illustrated on p. 503. The condensers, which are of the jet type, are as usual fixed under the engine room floor, and the pumps are driven by geared induction motors. The boilers are of the water-tube type, supplied by Messrs. Franco Tosi and Messrs. Babcock & Wilcox, and hand fired with Welsh coal.

The high-pressure power from Paderno is received on an overhead line, and is transformed down from 12,600 to 3,700 volts in Ganz transformers, 20 in number, of 400 KW. each; the secondaries of these transformers are in parallel with the steam-driven alternators on the main bus-bars.

MILAN: TRANSFORMER KIOSK.

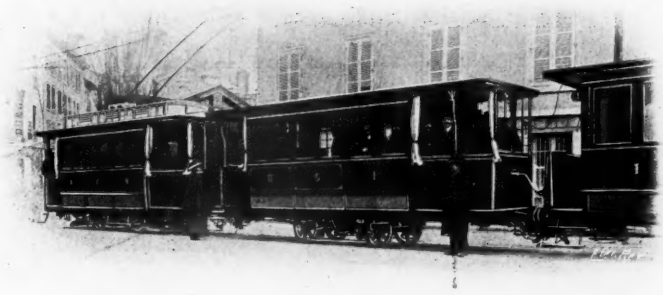
The high-pressure underground network is fed by 15 cables of Messrs. Pirelli's make, and the pressure is reduced to 160 volts, for distribution to consumers, in overground kiosks of the type illustrated herewith. Supply for lighting and power is derived from the low pressure mains in common, there being more than 3,000 three-phase motors connected with the mains, representing over 10,000 H.P. Compared with this, the lamp connection—77,000 incandescents and 721 arcs—is of secondary importance. On the other hand, the direct current supply, obtained from Santa Radegonda sub-station by means of motor-generators of 2,500 KW. output for traction, and 1,870 KW. for lighting, supplemented by Tudor batteries of nearly 2,000 KW. output for traction and 2,500 KW. for lighting, provides for 80,000 glow lamps, 1,000 arc lamps, and nearly 300 cars.



MILAN: SUB-STATION, SESTO SAN GIOVANNI.

Besides the supply to Milan proper, there is a large demand from the surrounding districts, which is met by the Edison Co.; the principal tramway line outside the city limits is that which runs to Monza, and this is supplied through the sub-station of Sesto San Giovanni, which we illustrate. The latter is equipped with a large storage battery and rotary converters.

The whole undertaking has a maximum load of 16,000 KW., a fact which sufficiently indicates the magnitude of the service, and the immense progress which has been made since the pioneer plant was laid down in the early eighties.



Electric Train: Grenoble—Chapareillan Tramways.

THE CONGRESS OF THE "HOUILLE BLANCHE."

By MARCEL BLOCH, Ingénieur Civil.

(*Continued from page* 404.)

Utilisation of Water Power in France.

Foremost in the utilisation of water power are the mountainous regions lying between the river Rhone and the Alpine mountains of the Swiss frontier.

Estimates of the power available indicate a value equivalent to 5,000,000 H.P. Of this large reserve, there is about 500,000 H.P. in actual requisition.

It is unquestionable that the application of water power would be an immense benefit to French industry, which is at present severely handicapped by reason of the tribute laid upon it by the heavy cost of imported coal. The coal production in France is, in fact, much inferior to the consumption, and more than 14 million tons of coal, of a total of 46 millions annually burned in France, are imported from abroad.

Typical Mountain Torrent.

The impetus to industrial development caused by the utilisation of water power in this district will be best illustrated by the following summary of a report of a visit recently made by the writer to some of the most interesting works erected for this purpose.

Very varied examples are to be found, all of which, however, possess a common character which makes the continuous utilisation of power somewhat difficult.

In the French Alpine regions there are, in general, no such things as large and steady flows of water, but mountain streams of very irregular character are the rule, mountain snows, and, more rarely, mountain lakes constituting the only reserve.

The first and most general form of reserve found in the Alpine regions therefore consists of snow, and climatic conditions make the supply very irregular and variable in magnitude.

The suggestive designation of "houille blanche," which, though untranslatable, will be self-explanatory to our readers, has been given to all similar water-powers by Mr. Aristide Bergés, whose work at Lancey deserves a first place record in the history of the development of water-power which these districts will witness in the near future.

The first use made of water power in this region was the manufacture of wood-pulp and paper in Mr. Bergés's factory.

Exterior of Generating Station.

Later, a lighting distribution was made to 10 villages of the Grésivaudan district. Finally, the electric railway line from Grenoble to Chapareillan, comprising a length of 43 kilometres, was installed by the Creusot Co., who obtained their water power from Mr. Bergés's installations, and erected a generating station for their direct-current three-wire system of traction.

The aggregate power of Lancey's installations includes the following waterfalls :—

Height of fall.	Quantity of water per second.
200 m.	500 litres.
527 „	500 „
474 „	800 „
514 „	800 „

giving a total of nearly 11,000 KW.

The above is a liberal estimation of the maximum power available. The minimum power available is much less, bearing to the maximum the ratio of 1 : 5 (about).

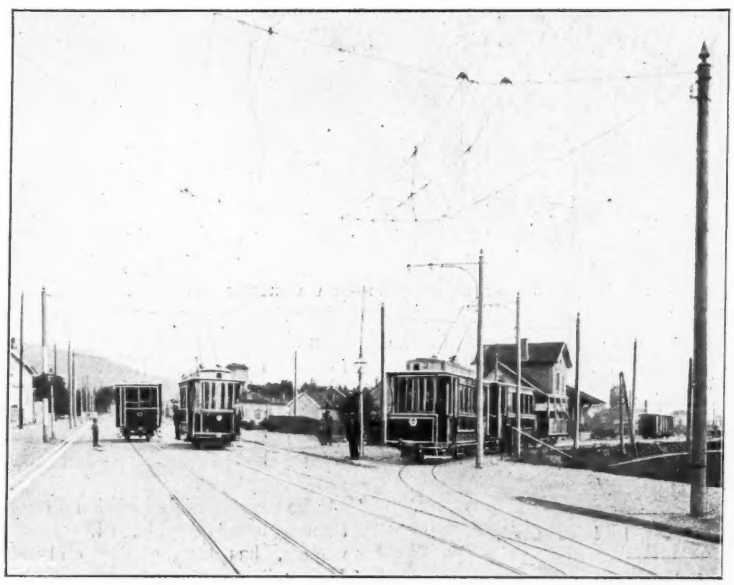
The generating plant provides for the following power installed :—

1. Paper factory, a few large and small units, of 200 H.P.

2. Electric lighting of Gresivaudan Valley : two main units respectively 200 and 300 KW.

3. Electric tramway from Grenoble to Chapareillan : three sets of 250 KW., two of which are in service.

This latter station uses part of the power of the third fall, of a height of 474 metres. The station is not owned by Mr. Bergés, as are those at the first and second falls. The latter, however, owns the falls and sells power therefrom to the owner of the station, which is the tramway company.



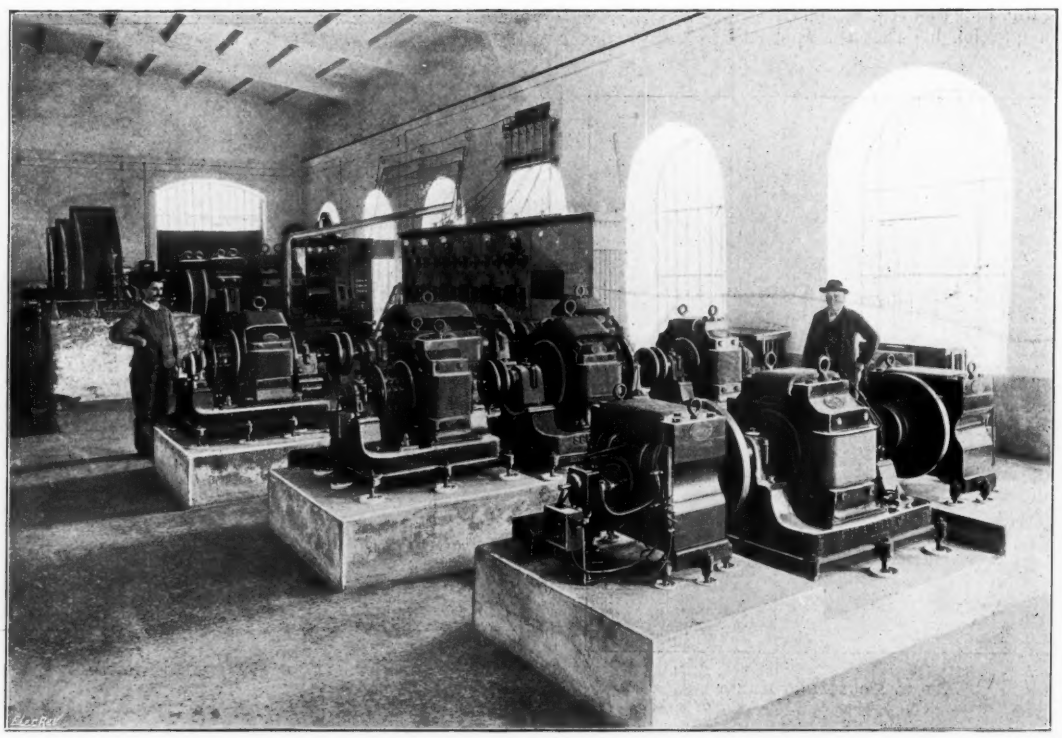
Junction on Three-wire Electric Tramway, Grenoble—Chapareillan.

Thus, if the electrical efficiency of the generators = 80 per cent., the final cost of the KW.-hour = 0·025 fr. for water rent, or about one farthing.

Lighting System of the Gresivaudan Valley.—This lighting system has a development of about 44 kilometres per sec., and the total power distributed does not exceed 200 KW. The interesting features are mostly in connection with the line construction, transformer construction and insulation, and the following brief description will be sufficient to give a complete idea of the whole system.

The Generating Station. — This is situated in the neighbourhood of the Bergés paper factory, that is, at the outlet of the pressure conduit working under a head of water of about 470 metres.

Two generating sets are installed, one of 200 KW. and the other of 300 KW., each of them composed of a centripetal Brenier-Neyret turbine and a Labour single-phase alternator, built by the Société l'Eclairage Electrique. The turbines are free deviation system, partial distribution, with a speed regulator acting on the moving vanes of the water distributor. The number of revolutions per minute is 350. The terminal voltage



Interior of Generating Station.

It is interesting to note that the contract price for water is 100 fr. per year per horse-power, measured from a water meter, with a guaranteed minimum of 25,000 fr. per year.

The turbine efficiency is admitted to be 75 per cent.

of the alternators is 125 volts, and the frequency is 50 cycles per second. The exciters are run from the main generating sets by means of belt transmission.

To raise the voltage from 125 volts to 12,000 volts,

which is the line voltage, six transformers of 100 KW. each are installed, built by the Société l'Eclairage Electrique, like the generators. The especially interesting feature is the paraffin insulation, contained in an iron box.

The switchboard is made of three panels, the two outer controlling the output of the alternators, and the inner one being used for coupling the alternators.

The 12,000-volt line is made of three naked copper wires of 40 mm². section, supported by Parvillée insulators, of the double petticoat type. These insulators are placed 60 cm. apart, and protecting nets are placed beneath the line at crossings of roads and railroads at a distance of 80 mm. from the lower conductors.

Distributing wires run from the high tension line to the customers' transformers, and consist of copper wires 3 mm. in diameter.

Two lines run from the station, one north, about 4 kilometres in length, and the other south. This latter connects with the Grenoble-Chapareillan line, along the route of the tramway, as described below.

The furthest point from the station, where power is delivered by the line, is 20 kilometres distant. The total length of the line is 44 kilometres.

The consumption of current is derived from the minimum possible number of transformers, but there is no great aggregation of population along the line. These transformers are, therefore, small in size, and their numbers are as follows: —30 3-KW., 15 5-KW., 5 7-KW., and 6 50-KW. transformers, all stepping down the voltage from 12,000 to 120 volts. One of the most interesting details concerning the line is the arrangement of the transformers on the poles carrying the line. They are simply supported by cross-bars connecting two poles, fixed one over the other.

Similarly to the station transformers, the line transformers are insulated by paraffin, and special care has been exercised in making a watertight cover for the iron box containing the paraffin and transformer core.

The construction of the line is simple and cheap, in order to assure a popular demand for current. The poles are of wood permeated with creosote.

There are actually about 800 customers, using about 6,000 incandescent lamps, ranging from 5 to 25 C.P. per lamp. The ruling prices are as follows:—

For regular customers the price for—

One 10-C.P. lamp per year is		25 fr.
Two	ditto	40 „
Three	ditto	55 „
Four	ditto	65 „

For each lamp above this number a charge of only 5 fr. is made.

The writer has the pleasure to tender his thanks to Prof. F. Loppé for his kind communications of data concerning the above installations.

III.—Electric Tramway from Grenoble to Chapareillan.—This tramway has a length of 43 kilometres, so that the ordinary 600 volts circuits would have necessitated either the construction of several generating stations or a very considerable expense for copper, and for this reason the three-wire system was preferred, with 1,200 volts difference of potential between outside wires.

Along the whole length of the track two copper wires, diameter 9 mm., are arranged 70 cm. apart. These two wires are fed by feeders with a difference of potential of 1,200 volts.

Each car has two axles, each with a four-pole Thury motor of 35 H.P. mounted thereon, in circuit with the two overhead wires. The return is made by the track, constituting the neutral wire connected to the neuter terminal of the switchboard. The current is collected by means of two trolleys.

The cars have central passages, and seat 36 passengers. They weigh 9·2 tons empty. The controller and resistances are placed on the roof and worked by means of a wheel and chain by the motorman. They are provided with a hand-brake, and also an electro-magnetic brake worked by the motors acting as generators.

Each train is formed of three motor-cars, as shown in the illustration on p. 505, and the power station is of sufficient capacity to operate in continuous service nine trains of 28 tons each. The maximum grades are 4 per cent.

The generating station is situated close to the Bergés station, and employs part of the water from the 450 metre fall. The contract price for the power has been fixed at 100 fr. per horse-power per year with the minimum charge of 25,000 fr.

The pressure being constant, all that was necessary to measure the power was to know the amount of water passing through the turbines. For this the water is led to a large cylinder around the top of which are placed 80 identical holes, and the bottom being closed, the water naturally flows through these orifices. The water from one of such orifices is then sent to a graduated reservoir and there measured.

The power station, illustrated on pp. 505 and 506, includes three generator groups, each with a Brenier-Neyret turbine direct coupled by elastic coupling to a Thury dynamo, with six poles, giving 600 volts, with a current of 417 amperes, and a speed of 325 r.p.m. Two of these groups are used, the third being held in reserve. These two dynamos are run in series, with their positive terminal connected to the positive of the switchboard and the negative terminal to the negative of the switchboard, whilst the common terminal of the dynamos is connected to the neutral of the switchboard.

The dynamos are compounded so that the pressure at the terminals is 600 volts constant. The shunt excitation circuit includes a regulating rheostat worked by an automatic regulator on the Thury system. The neuter bus-bar is connected by a cable of 125 sq. mm. section and of 3·2 km. length to the tramway rails.

The line is divided into three sections, Grenoble, Drogeaux and Chapareillan, which can each be isolated from the circuit if need be. Each of the two wires of each section is fed at about its middle by a feeder from the corresponding bus-bar of the station switchboard, so that each section has its positive and negative feeder.

The following table gives the length of the sections, the cross-section of the feeders and the fall in voltage in each section of the line:—

Section.	Length.	Section of feeder.	Maximum fall of pressure.
Grenoble ...	23 m.	90 mm².	360 volts.
Drogeaux ...	5 „	64 „	150 „
Chapareillan ...	13 5 „	125 „	225 „

The seven wires leaving the station (six feeders and the neutral wire) are led directly over a footbridge across the railway, span the Isére (125 metres span) and follow the track for the remainder of the distance.

The line is equipped with metal poles, and double petticoat insulators of the André system are installed.

On each feeder is installed a booster or series excited generator, the voltage being thus boosted up to the normal. The two boosters on the two wires in the same section are worked by one motor by means of a special Raffard coupling, as shown in the illustration on the opposite page. These machines are respectively of 80 H.P. (Grenoble section), 40 H.P. (Drogeaux), and 56 H.P. (Chapareillan section), and are compounded for constant speed, and connected between the outside wires of the switchboard.

Each booster is furnished with a ratchet to avoid accidents from reversals of the booster. This ratchet short-circuits the armature of the booster, which immediately stops.

Before being connected to the line the feeders pass through a switchboard supplied with automatic switches to prevent the current from becoming dangerous to the boosters. The complete equipment of station, line and rolling stock is due to the Creusot Cie.

Imports of Foreign Electrical Apparatus and Machinery.—The imports of foreign electrical goods and apparatus into this country during August last reached the largest monthly total so far recorded, viz, £78,407, which compares with £60,486 in July last and £57,388 in August last year. The aggregate imports for the eight months ending with August last are returned at £499,807, and increase of £35,140 as compared with the first eight months of 1902. On the other hand, the imports of foreign electrical machinery were last month on a reduced scale, being only £33,791, bringing up the total for the first eight months of the year to £391,537.

CONTRACTS CLOSED.

(*Continued from page 502.*)

Brighton.—The T.C. has accepted the offer of the British Westinghouse Co. for two rotary converters for the electricity works in place of two synchronous motor-generators. Also the tender of the Reason Manufacturing Co., Ltd., Brighton, for the supply of direct current ampere-hour or watt hour-meters for one year.

E.P.S. Batteries.—The contract for the storage battery for the Walsall Corporation Butts Road sub-station has been placed with the Electrical Power Storage Co., Ltd. The same company has also received the contract from the Nottingham Corporation for the battery for the City Asylum. The St. James's and Pall Mall Electric Light Co., Ltd., has placed the contract for the extension of the storage battery with the Electrical Power Storage Co.

France.—The French Post and Telegraph authorities in Paris have just given out a number of contracts as follows:—La Compagnie Générale d'Electricité, Paris, 60 tons of bronze wire, 11/10 mm. diameter, at 2,525 fr. per ton; La Compagnie des Trefileriès du Havre, 30 tons ditto, 15/10 mm. diameter, at 2,525 fr. per ton, 100 tons of high-conductivity copper wire, 4 mm. diameter, at 1,936 fr. per ton; and La Société Industrielle des Telephones, Paris, 12 kilometres of submarine electric cable.

Hackney.—The Borough Council has received the following tenders for electricity supply mains:—Western Electric Co. (accepted), £2,105 7s. 6d.; Henley's Telegraph Works, £2,614 19s. 10d.; Callender's Cables Co., £2,890; St. Helens Cable Co., £2,893; British Insulated and Helsby Cables, Ltd., £2,804; Siemens Bros. & Co., £2,124; Glover and Co., £2,941. For arc lamps and pillars:—Oliver & Co. (design of post A), £1,120; ditto (design of post B), £1,111; Crompton and Co. (design of post A) (accepted), £1,161; ditto (design of post B), £1,167; Johnson & Phillips (design of post C), £1,183; ditto (design of post A), £1,245; W. T. Allen & Co. (design of post D), £1,232; the Gilbert Arc Lamp Co., Ltd. (design of post B), £1,243; the Brockie-Pell Arc Lamp Co.. Ltd. (design of post B), £1,286; the General Electric Co., Ltd. (design of post E), £1,375; the New Century Arc Light Co.. Ltd. (design of post A), £1,510. For 500 electrolytic meters, the tender of the Reason Manufacturing Co. at 36s. 6d. and 60s. per meter according to size was accepted. For 500 motor-meters the tender of Messrs. Ferranti, Ltd, at 36s. and 117s. per meter according to size was accepted.

Hammersmith.—The B.C. has accepted the following tenders:—Additions and alterations to switchboard, Ferranti, Ltd., £360 4s.; supplying 38 arc lamps and accessories, Oliver & Co., £360 3s.

War Office.—The War Office has accepted the tender of the Premier Electric Lamp Co., Ltd., for a large quantity of incandescent lamps.

West Ham.—The Corporation has received the following tenders for tramway cables and telephone wires:—The Electrical Co., £9,132 tramway cables, £27 10s. telephone cable per mile; British Insulated and Helsby Cables, Ltd. (accepted), £9,325, £49; Johnson & Phillips, £9,420, £56; Siemens Bros. & Co., £9,444, £55; Land and Sea Cable Co., £9,798, £58; Glover & Co., £9,855, £53; Dennis & Co., £9,920, £37; Callender's Cable Co., £10,030, £51; Western Electric Co., £10,042, £50; St. Helens Cable Co., £10,473, £64; ditto (alternative), £10,038, £63. The following tenders were received for a traction switchboard:—J. G. Statter & Co., £1,989; Cowans, Ltd., £2,092; Electric and Ordnance Co., Ltd., £2,134; Witting, Eborall & Co., Ltd., £2,160; British Thomson-Houston Co., Ltd. (accepted), £2,183; Johnson & Phillips, £2,185; Bertram, Thomas & Co., £2,195; Kelvin & White, £2,290; Ferranti, Ltd., £2,355; ditto (alternative), £2,400; Estler Bros., £2,485.

FORTHCOMING EVENTS.

Monday, September 28th.—At 8 p.m. Institute of Marine Engineers. Mr. A. E. Mills on "Water-tube Boilers" (adjourned discussion).

Friday, October 9th.—Electro-Harmonic Society. First Concert of the season.

Wednesday, October 14th.—At 6.45 p.m. Institute of Marine Engineers. Annual Dinner at Great Eastern Station Hotel, E.C.

NOTES.

The Edison Cell.—Though little definite information on the subject of the rigorous tests to which the Edison cell is being subjected is yet available for publication, our readers will be glad to know the general tenour of the results. We are in a position to state, on unimpeachable authority, that the curves and data which we published in our issue of March 6th last, from the pen of Mr. W. Hibbert, the well-known expert, have been completely verified; moreover, valuable results have been obtained with still higher currents, and the performance of the cells on the road—a still more important matter—has been proved equal to their behaviour in the laboratory. Identical results have been obtained by the Continental experts who have been testing the cells. All the results will be made public shortly, and there can be no doubt that, as soon as the cells are placed on the market in quantity, an immense impetus will be given to the electric automobile industry, to which we wish all success.

Electricity Supply Companies and Street Obstructions.—The traffic in the more crowded parts of the metropolis renders it exceedingly difficult for electric lighting companies to effect repairs to their cables, or to connect up the premises of new consumers, without coming into conflict with the highway authorities. These bodies act, no doubt, in the interest of the wayfaring public, but it must be admitted that the steps which they sometimes take press rather hardly upon the electric lighting companies who are bound by Statute to fulfil their obligations to consumers. A recent case in the City Summons Court, which we record below, appears to us to place an undue burden upon the company whose conduct was called in question. Although it is true that by Sec. 81 of the Electric Lighting (Clauses) Act, 1899, nothing in the special order shall exonerate the undertakers from any indictment, action, or other proceedings for nuisance in the event of any nuisance being caused or permitted by them, and that therefore the company are liable for obstructing the thoroughfare, their liability should be measured on the footing that they have not only got the duty, but the right, to lay wires and alter them, and so long as they carry out their works with as little delay as possible, and with due regard to the safety of their own workmen, they should, in our view, remain unmolested. In this respect theirs is a different case from that of a pneumatic carpet-cleaning company, who sometimes find it necessary to stand their machines in the streets for a considerable period. The electric company acts in pursuance of a statutory duty, the carpet company in fulfilment of a private contract. We trust that when the case under notice reaches a higher court the rights and obligations of electric lighting companies with respect to the breaking up of the streets may be clearly defined.

On Tuesday, before Alderman Sir Horatio Davies, M.P., Edward Charles Ives, jointer in the employ of the Charing Cross and City Electricity Supply Corporation, appeared at the City Summons Court in answer to a summons for causing a truck to remain in Bishopsgate Street by Wormwood Street for a longer time than required for loading or unloading. Mr. Vickery (City Solicitor's office) supported the summons, and Mr. Walter Frampton defended. Mr. Frampton raised a point of law—that the company, working under statutory powers, were justified in having their truck there. After some discussion on this point, the Alderman decided against Mr. Frampton, who then called defendant and his "mate" to show that the truck was in use all the time. The Alderman suggested that the tools, &c., required by the defendant might have been kept under the tent covering the man-hole. Mr. Arthur Hudson, engineer, deposed that it was dangerous to have either their tools or their highly inflammable materials near the manhole. Anything going down the hole might complete an electric circuit, and an explosion would ensue. They also had their men to protect. Mr. Frampton said they had done all in their power to meet the police and carry out instructions. If any of their servants were obstinate they would not be defended. The City Corporation had it in their power to restrict the hours in which the work might be done, and he believed even now the Corporation had gone to the Board of Trade for the purpose of doing this; but he contended that at present they had no offence to answer. Sir Horatio Davies said he did not share Mr. Frampton's opinion, and should inflict a fine of 20s. and costs. On application he consented to state a case for the High Court.

Lectures.—Mr. A. G. Collis, electrical engineer, of Birmingham, has recently given a series of lectures at Oxford on "Alternating Current and its Problems."

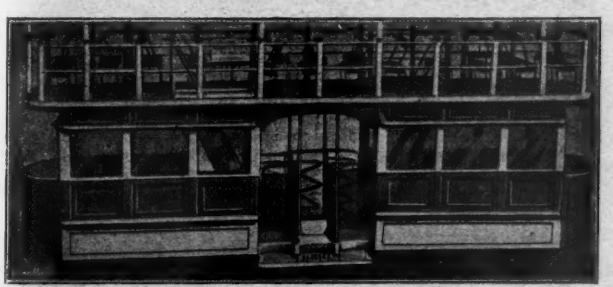
Electricity in India.—We have received a copy of the first issue of the *Indian Textile, Mechanical and Electrical News*, a monthly paper whose editorial offices are at Bombay. The journal will be neither popular nor heavily technical, the editor's aim being to cut in between the two. His electrical department will aim at meeting the requirements of the general public and users of electrical energy. Electrical engineering work is referred to thus:—"In India, at the present time, there is nothing that can be called an electrical industry. There are no factories for the production of electrical machinery, though the growing use of the same will, before long, create a demand for workshops that are sufficiently equipped to be capable of undertaking repairs of such apparatus as may break down or become damaged. The delay and expense involved in sending such work to Europe will thereby be saved, and this saving should ensure the success of such establishments."

Personal.—Mr. H. L. Williams, of Messrs. J. G. White and Co., Ltd., London, was presented on the 19th inst., at Shipley, Yorkshire, with a solid silver coffee service, of rich design, on the occasion of his marriage, by those connected with the construction of the new Shipley tramways. Mr. Williams is to be married on the 24th inst. at Winchester. He superintended the complete construction of the Shipley electric tramways, *i.e.*, overhead electrical equipment, permanent way, cables, car-sheds and cars.

Mr. John Dugdale, traffic superintendent of the Sheffield Corporation Tramways, has been appointed to succeed Mr. J. S. Halliwell as manager of the Oxford Tramways Co.

Motor and Tram Speeds.—About a month ago Mr. Moffatt Ford, managing director of the Motor-Car Co., summoned a London United electric car driver for driving his car at the rate of more than 10 miles an hour along Goldhawk Road, Shepherd's Bush. The object of the complainant was to demonstrate the unfairness of a state of things by which an electric car could travel at the rate of 17 miles an hour, while a motor-car was forbidden by the new Motor-Car Act to go at a greater speed than 10 miles an hour in towns and populated districts. The matter came before the West London Court on two occasions. Mr. Muir, in defence, said the tramway company could conclusively prove that none of their cars timed by the prosecutor could go at a greater speed than 13 miles an hour; and he suggested than an independent test might be made by an official of the Board of Trade for the benefit of the Court. The magistrate said the matter was important, and he thought the learned counsel's suggestion a good one. He adjourned the summonses in order that an official test might be arranged. On Friday last week Mr. Ford again appeared before the magistrate and complained that although a month had elapsed since the last adjournment, and although a referee had been agreed upon between the parties, yet he could not obtain an appointment for the test from the defendants, who did not seem at all anxious to hurry the matter forward. The magistrate (Mr. Lane) remarked that Mr. Rose, before whom the previous hearings had been taken, would return very shortly to the Court, and he had no doubt that before that time the defendants would come to some arrangement with Mr. Ford for the official test to take place in ample time for the case to be continued immediately Mr. Rose recommenced his sittings at the Court.

The Car which Passengers "enter and leave at the same time."—Mr. William A. Bristow, the patentee of the miraculous car mentioned in our issue of the 14th inst., complains that we have not done his invention full justice, and sends us a leaflet illustrating and describing the car in ordinary type. It is true that this is easier to read than the MS. submitted to us first, but the invention seems to lose romance somewhat. It does not by any means lose its astonishing advantages, however, and we are delighted with a cut at the top, reproduced evidently from a photograph of a model. It is worth reproducing again, just to show what



The Bristow Car.

kind of thing is patentable by the score every day. Considering that one-quarter of the lower deck is occupied by the entrances, which presumably form the subject of the patent, and that the stairs to the upper deck occupy, or should occupy, the same space *inside* the car that they do when filling unpatented positions, it is somewhat difficult to see how a 30-ft. car can seat 68 passengers, unless each passenger is given no more room than appears to be allowed to the motorman, to say nothing of his controller and brakes.

However, we do not care to quibble about a trifle like that when we read, as below, some more of the points about this car:—"It has numerous advantages over the existing cars, and can be arranged for conduit, overhead and contact systems, &c., &c., and may also be fitted with its own motor power by fixing same on each end of the driver's platform, and may be driven with or without rail; the latter, of course, would enable the cars to be brought close to the pavement, and, if adopted, would be able to pass over bridges." The discovery of the radiant element itself pales before this.

The Electro-Harmonic Society.—Mr. H. E. Lane, the hon. secretary of this society, has issued a circular announcing the concert arrangements for the ensuing eighteenth season. All of the events will take place at the Holborn Restaurant. The smoking concerts will be held in the Crown Room on each of the following Fridays, October 9th, December 18th, January 22nd, March 25th. The ladies' nights will be conducted in the King's Hall on Fridays, November 13th and February 26th. In view of the success of the special extra concert in the King's Hall, on June 5th last, the committee have engaged this hall for the two "ladies' nights," and they express the hope that the increase in membership during the coming season may be such as to justify the engagement of the King's Hall for all the concerts in future seasons. Mr. Lane (14, Durley Road, Stamford Hill, N.) will be glad to send proposal forms to any of our readers who wish to become members of the society.

Berlin High-Speed Railway Tests.—Reuter reports from Berlin that further speed experiments on the electric railway at Zossen have resulted in a speed of nearly 114 miles an hour being attained.

South African Notes.—Our Johannesburg correspondent writes:—

Telegraph reconstruction work has advanced beyond Haenertsburg, and the work of completing the line to Leydsdorp is proceeding rapidly. As the line is expected to be completed to the latter place by the end of the month, the re-opening of the system has been deferred to that date.

Potchefstroom.—The Potchefstroom Consumers' Electric Light and Power Co. has commenced operations, Mr. Skirving, the resident magistrate, performing the ceremony of switching on the lights last week.

Telephone Development.—The Postmaster-General desires, in the public interest, to call attention to the following matter:—

"In many of the large buildings in course of erection and projected in Johannesburg, it is probable that there will be a demand for a 'domestic' telephone service—that is, a system of communication from room to room within the building—with connections with the Government telephone system of the country. The owners of such buildings should understand that the erection of telephones and telegraphs in the Transvaal is a Government monopoly, and they are cautioned against entering into contracts with private firms for wiring such buildings for telephonic purposes without reference to the Postmaster-General, who is prepared to entertain applications for carrying out such work departmentally. Apart from the legal aspect of the question, it is obvious that serious inconvenience would be caused to the owners and occupiers of buildings if, after the installation of a 'domestic' service, it were found that it could not be connected with the public telephone service, owing to a different system having been provided."

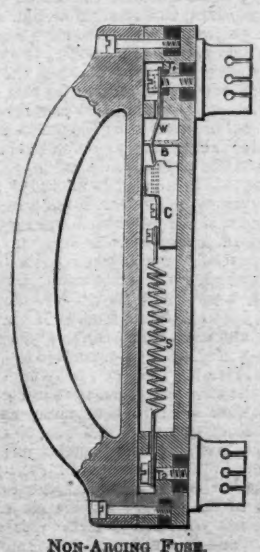
Natal Railways.—The Natal Government railways invite tenders for the erection of the whole equipment of the boiler house of the new electric power station at Durban, and also for the installation of electric light at the Indian and Native Barracks, Greyville, Durban.

Cradock.—The Town Council has received two tenders for the installation of electric light for the town as follows:—From Messrs. Harper at £400 per annum, and from the Pioneer Gas and Electric Light Co. at £500 per annum, the charge to consumers being the same in each case, viz., 1s. per unit.

Johannesburg.—The Johannesburg Municipality requires the services of an assistant electrical engineer at a salary of £26 per month.

Ladysmith Telephones.—The installation of the Ladysmith telephone system is now almost completed, 50 subscribers being provided for. The system is under Government control, the charges being £10 per annum for the first instrument installed on business premises, and £5 for each additional one. In private houses the instruments are connected for £5 per annum, this, however, not applying to the medical profession, who pay the same as business men.

New Fusible Cut-out.—A patent specification recently completed (No. 13,267, 1902) describes a fuse provided with a quick break, which may be of considerable utility. The principle is clearly shown in the adjoining illustration, which is a partial cross-section of a complete earthenware switch-fuse. It will be seen that the fuse-wire W is stretched over a bridge-piece B, and is fixed at one end to a terminal T_1, at the other to a sliding block C, which is pulled by



Non-Arcing Fuse.

a spiral spring S so as to keep the fuse-wire in tension. The other end of the spring is attached to the other main terminal T_2, thus completing the circuit through the spring. When the fuse melts it will give way at the bridge-piece, and the ends will immediately be widely separated by the action of the spring, so as to break the arc. Various modifications of the principle are described in the specification. For example, provision is made for the admission of air through an aperture over the fuse-wire, the sliding block acting as a piston and producing a partial vacuum; but probably this would be prevented by the expansion of the heated air on the blowing of the fuse. The passage of the current through the spring appears to

us to be an objection; but this can be avoided, and the principle of the device is certainly sound. We have seen a somewhat similar apparatus, the details of which have not, we believe, been published; but the question of priority must be decided by others.

The fuse is the invention of Mr. W. P. Burke, of Grove House, Fethard, Ireland, who is seeking a purchaser for the patent.

7,000-kw. Parsons Turbine.—Messrs. Brown, Boveri and Co. have in hand for the Rhenish—Westphalian electricity works a steam turbine coupled to a 5,000-kw. alternator and a 1,500-kw. dynamo, the output of the turbine being therefore about 7,000 kw. This will, therefore, be the largest steam-driven set in the world. The steam consumption is guaranteed not to exceed 15·4 lbs. per kw.-hour, a record result, unless highly superheated steam is employed, and it is hoped that a still lower consumption will be attained. The set will measure 18 metres in length and less than 3 m. in width and height. The turbine itself will be only 7 m. long.

The Co-operative Ironworks at Guise (France).—A pamphlet has recently been issued by the Labour Co-Partnership Association describing the "Familistère" at Guise, in France, which was founded by the late M. Godin, and has now been running successfully for 20 years on co-partnership lines. The business consists in the manufacture of light cast, wrought and enamelled iron goods, such as stoves and the like. The concern is a "Société en simple Commandite," *i.e.*, a company in which the principle of limited liability covers all the shareholders except the managing director, and of which the proprietors at any moment are automatically the existing generation of workmen, clerks and officials. This curious arrangement was devised by M. Godin himself. He executed a deed handing over his factory to the men under a profit-sharing scheme, in which the profits took the form of shares, until, by retaining the cash (the actual profits) himself, M. Godin was bought out at the price agreed upon. The same principle is still maintained according to seniority, the oldest shareholding hands being paid out in rotation, and new scrip being issued to such younger men as are entitled to it uninterruptedly. The employés, of whom there are about 1,600, are divided into four classes (men and women alike): Helpers, who come and go, participate only in insurance against illness and accident, and in pensions if necessary; profit-sharers, who receive one share in the profits calculated on their wages; associates, who receive one and a half shares; and partners, who take two shares each, and who now number some 300. A worker who can read and write and behaves well may become a profit-sharer in five years if he lives in the communal dwellings. A profit-sharer living outside the dwellings receives an associate's profit after 20 years. Profit-sharers and associates living inside receive partners' profits after 20 years' employment; but they have no voice in the control of the company until they have been elected actual partners. The profits divisible among the hands are not paid in cash, but as "saving certificates," *i.e.*, capital; and on the sum so invested each man receives interest at the rate of 5 per cent. The concern is managed by a committee elected by a general meeting of the partners; it consists of a general manager (chairman), works manager, commercial manager, several departmental managers, the chief accountant, and the house-steward, who is the head of the partnership dwellings, &c., together with three other committee men chosen annually; while a second committee "of supervision," also elected by the partners, acts something like a standing board of auditors. The gross profits every year have first to meet depreciation of buildings and material; secondly, the various insurance funds; and, thirdly, the cost of educating the children of the hands, the remainder being net profit. Of this, 75 per cent. is awarded to wages and capital, being used as a fund out of which to pay interest on the capital invested by the profit-sharers at the rate of 5 per cent. as stated above and to cover, at the rates previously given, dividends upon the wages of all the hands. The residual 25 per cent. of the net profit is allotted to "ability," *i.e.*, 4 per cent. is given as salary to the managing director, 16 per cent. is divided among the committee of management, 2 per cent. among the committee of supervision, 1 per cent. is employed, if necessary, to maintain the children who have passed through the schools of the company in outside Government educational establishments, and the last 2 per cent. is left for the reward of useful inventions, &c. Blocks of flats are provided for the employés to live in, if they will, where the rent charged is low, and the accommodation varied to suit families of all sizes; baths, wash-houses, co-operative shops, a public park, library, theatre, &c., forming part of the social side. The capital required to finance the shops is found by the society. The shops (like the park, &c.) are open to the public, and the hands are equally free to deal elsewhere. The profits of the shops are returned to the hands in credit notes against future purchases, and are approximately equal to the rents paid for the flats. Parents of children who live in the co-operative flats are under agreement to have them taught in the private schools or elsewhere till the end of their fourteenth year, and there is a *créche* in which infants of a few weeks old are received while the mothers are at the factory. All the expenses of the schools, parks, general cleaning of the dwellings, shops, &c., is borne by the society itself. A sick fund is provided by compulsory payment of 1·5 per cent. on the wages of all hands living in the flats, and of 1 per cent. on those of the men living elsewhere, the society then adding a sum equal to that paid in by all the hands. A pension and necessities fund is provided partly out of the gross profits at the rate of 3 per cent. on the wage bill, and partly from the retained profits not paid to the helpers. Sick pay and pensions are only given nominally at rates fixed on the wages taken; but in cases of urgent want the family is assisted temporarily out of the necessities fund. The society was started in 1880, when the average daily wage of the hands was 3s. 5d.; in 1891 it had risen to 4s. 3½d., and, with occasional fluctuations, it still rises. The annual wage bill is over £80,000; and since 1880 £180,000 has been distributed among the men over and above their salaries, while the capital invested has only been paid to the extent of £16,000. Since 1880 also £72,000 (the 25 per cent. of the net profits) has been apportioned to "ability," the 4 per cent. given to the managing director coming to between £443 and £666 per annum. We cannot altogether consider this last sum a princely salary for a man who is responsible for the management of a factory employing 1,600 hands, more especially when we remember his unlimited pecuniary liability.

The Philanthropy of Self-Help.—An article bearing the above title, written by Mr. Louis Bell, Ph.D., appears in the September issue of *Cassier's Magazine*. The paper consists partly of Dr. Bell's personal remarks upon certain aspects of the labour problem, and partly of a description of the arrangements made for running a large engineering factory, near Philadelphia in the States, where conveying machinery is chiefly manufactured. Dr. Bell ably points out what intolerable nonsense is talked about "the good old times" and the superior workman of the past; for, as he says, the present day working man has many more wants than his ancestors, and is vastly better able to satisfy them in his domestic and political affairs. Again, "We instinctively think of artists like Cellini, happily forgetful of the countless hordes of bunglers who have wrought with clumsy hands abominations which have cumbered oblivion since the days of Tubal Cain." This line of argument, by the way, applies to many matters besides the imaginary workman of by-gone days, such as the wealth of all Americans, the superiority of their workshops, the perfection of German universities, and the like.*

Dr. Bell attributes the greater spread of the eight hours' day movement here than in the States to the one or two hours' work before breakfast characteristic of Great Britain; Americans, he says, would be ripe for strikes or riot in a week if they were made to start without a meal. Certain it is that this early morning work is often very badly done, and much of the time is wasted. Referring to the factory of which he treats at length, Dr. Bell states that the hours have been reduced in two stages from 10 to 9, wages and piece-work rates remaining unchanged, the net result being that the labour cost per ton of output for the 9-hour day was 15·5 per cent. less than that during the 9½-hour day, and 28·5 per cent. less than the cost during the 10-hour day. In passing from 10 to 9 hours the men have gained 15·3 per cent. in the average rate per man-hour, or a net gain of about 5 per cent. in daily earnings. The manager firmly believes in the inequality of man, he adopts piecework as much as possible, and raises the basic piecework rate when a certain minimum output is passed by each hand.

Lunch rooms, insurance schemes, co-operative shops, and so on, he dismisses as "soup-house philanthropy," and prefers to put his men in a position to look after themselves rather than to force his views of life and recreation upon them. The shop is now non-union, but some time ago it became affiliated. The manager took an early opportunity of asking whether the men had any grievances, to which they replied, "No!" He next inquired whether they would strike if called out in sympathy by the union, to which they again replied, "No!" Then, said the manager, "if you will not keep faith with your union by striking when ordered as you have promised, I cannot trust you to keep faith with me; and in order to maintain your self-respect, I shall see that you do strike." This branch of the union, according to Dr. Bell, is now defunct. The same manager has put forward a very plausible theory to explain why the young workman joins a union, ascribing his action to a wish to be thought emancipated or grown up. A lad, made foreman, once asked him for a written certificate of his promotion, because his people at home always called him "that boy!"

Northampton Institute.—The evening courses and classes in engineering, artistic crafts and other technological subjects at Clerkenwell will begin on Monday next, September 28th. The day courses in Engineering commence on Monday, October 5th. The usual very complete syllabus, with illustrations of the various departments, has been issued by the Principal, Dr. R. Mullineux Walmsley.

London Traffic Commission.—It was announced last week that several members of the Royal Commission, including Sir David Barbour and Lord Ribblesdale, had left for America to make certain inquiries as to street railways and tramways in Boston and New York. Sir Francis Hopwood, who was to have accompanied them, was detained by pressure of official business.

Radium.—The American Museum of Natural History in New York City has received a quantity of radium which is not very large, but the radio-active power of which is second to none in that country. It was given, says an American Exchange, to the Museum by Mr. Edward D. Adams, whose immediate object is to enable George F. Kunz, the gem expert, and Dr. Charles Baskerville, of the University of North Carolina, to carry on some experiments with gems. Mr. Kunz is very much interested in discovering the properties of the new gem, Kunzite, which it is reported is very phosphorescent when exposed to the radium rays. A beginning has been made in the examination of the Bement-Morgan and Morgan-Tiffany collections of gems with the X rays and radium rays. A report of the results will soon be made in a special publication of the museum. The specimen of radium which has been imported for the museum is of 300,000 radio-activity.

* *De hostibus nil nisi bonum*, so to say.

Obituary.—In Moritz Immisch, who passed away suddenly last Sunday, the world has lost one of the earliest pioneers in the development of electric power. A born inventor, his restless mind teemed with ideas; but it is in connection with the "Immisch" motor his name is chiefly known, although the records of the patent offices of Europe and America prove him to have thought out more or less thoroughly many practical physical problems. Born and educated in Thuringia, graduating at a German university, Moritz Immisch made a special study of horology, and coming to London about 40 years ago, rapidly made a name among the chief watch and clock manufacturers. He obtained in 1872 the Baroness Burdett-Coutt's prize for an essay on "The Balance Spring." His talents, however, were not fully occupied in this limited work, and his experiments in electricity, magnetism and general physics soon attracted friends and capital. About 1880 he entered into a business partnership with the late Fritz Hubel, a fellow-countryman, and several Englishmen found the necessary capital to extend the scope of his experiments. Small works were opened at Malden Crescent, Kentish Town, and the "Immisch" motor was gradually evolved, and won medals at the Inventions Exhibition of 1885, the Antwerp International Exposition of the same year, and at various subsequent exhibitions. From thence to 1891 the firm seemed on the high road to success. The works were full of pioneer orders for dynamos and motors for running plant, electric launches, &c. But costly attempts to foster electric traction led to financial disaster. The firm was ahead of the times, and after suffering various vicissitudes of fortune the Malden Works were closed, and Moritz Immisch retired from manufacturing work, appearing publicly only as a director of the Immisch Electric Launch Co., of which he was the founder. As an employer, his decease will be regretted by the many men who passed through the Malden Works, and who, scattered all over the world, will think kindly of the large-hearted burly German, unapproachable to-day, yet ready to-morrow to appreciate merit and loyal services. Starting in a foreign country with no advantage other than his own ability, Moritz Immisch attained no small degree of success, and might have gone much farther but for the unfortunate death of his business partner, Fritz Hubel, in New York, about eight years ago.

Superheater Tests. — We have received from Prof. Watkinson a sheet of tests of a superheater, showing a degree of superheat of 153·5° F. reduced to 131° F. at the engines 87 ft. distant, thus showing an abnormally small drop in temperature of less than 1° F. per yard of steam pipe. We can scarcely agree that this small drop, even if correctly measured, can be explained on the assumption that it is due to the fact that all the steam has been superheated, and not simply a portion of it, which we are invited to believe would be the case if the drop were greater. How would it be possible at the outgoing of a superheater for a properly inserted thermometer to show a higher temperature than that proper to the mean steam flow? Surely when the many tubes of any class of superheater have delivered their contents to the common outgoer it is not to be contended that saturated and superheated steam are coexisting at that point, and even if they were, their mean temperature would appear at the thermometer. The tests show that for 1,313 lbs. of coal per hour, as against a previous consumption of 1,324 lbs. the horse-power electrical is raised from 176·2 to 240·8—a gain of 36·6 per cent. The steam per E.H.P.-hour is reduced from 44·9 to 31·7 lbs., and coal from 7·51 to 5·45 lbs., which represent savings of 29·3 per cent. of steam and 27·4 per cent. of coal.

Without disputing the possibility of the figures, it may be pointed out that 7·5 lbs. of coal and 44·9 lbs. of steam are very large values, but there is not a scrap of information as to how the E.H.P. was found. The figures are given as averages. What is the load factor? What duty were the dynamos performing? How was their output measured? No one to-day is likely to dispute the economy to be derived from superheat, but some of it, as probably in this case, is derived from evaporation of priming water, and figures like those before us give colour to this presumption.

Prof. Watkinson is quite correct in the fears he expresses in regard to the danger of flooding superheaters. Superheaters should not require flooding to keep them from burning out, nor should they be exposed to the risk of sending forward red-hot steam to the engines. Unfortunately, cheapness of first cost is too much looked at. A superheater ought to be a piece of high-class boiler work, and it should contain its own elements of safety and control.

Prof. Watkinson advocates independently-fired superheaters at sea with superheat of the steam initially and after each stage of expansion. A system of superheat suggested consists of a closed length of pipe with coils in the furnace or combustion chamber and in the steam pipe. This idea, however, is not new. Thwaite's patent covers this arrangement. He suggested glycerine as the circulating fluid, but in a closed coil of small pipe. Why is not pure water good enough? It is satisfactory to see the present interest in superheat, and it is to be hoped that users of superheaters will demand superheaters which will be free from troubles of burning out and of red-hot steam, and also out of reach of the necessity of flooding.

Ferranti, Ltd.—Messrs. A. W. Tait and Arthur Whittaker, the joint receivers and managers, announce that it is their intention to continue the business without interruption, and all goods supplied and work done under their authority will be paid for in the ordinary course.

Telephones to Belgium. — The existing telephone service between London and Brussels is to be considerably extended on October 1st.

Bond v. The British Electric Street Tramways, Ltd. —In the Vacation Court on Wednesday, before Mr. Justice Bucknill, this case was mentioned. It was a motion to restrain the defendants from dealing with certain assets, but on an undertaking being given in the terms of the notice of motion, his Lordship directed the matter to stand over for a week to enable the evidence to be completed.

Appointments Vacant.—The Government of Lagos requires a superintendent of electric lighting (£400), and an assistant electrical engineer (£300); station superintendent for Motherwell (£117); draughtsman for Ilford Electricity Works (£100). See our advertisement pages to-day.

THE CENTRAL STATION ENGINEER.

The Bradford Electricity Committee received 70 applications for the post of electrical engineer vacated by Mr. R. A. Chattock. From these three were selected, as follows:—Mr. Blackman, of Poplar; Mr. D. Wilson, of Bankside station of the City Co.; and Mr. R. S. Downe, of Southport. Mr. Blackman was selected by a majority of the Committee.

Coventry T.C. has appointed Mr. Lucock, assistant mains superintendent, to succeed Mr. Sowter as mains superintendent.

Mr. J. F. Macgoris, of Hampstead, has been appointed assistant electrical engineer at the Hull Corporation Electricity Works.

Mr. Bastow has resigned the post of resident electrical engineer at Barnsley, and Mr. Barker, assistant electrical engineer, has been appointed to succeed him at a salary of £225 a year, rising, after March 31st, to £250.

NEW COMPANIES REGISTERED.

Penarth Tramway Syndicate, Ltd. (78,569).—This company was registered on September 16th, with a capital of £3,000 in £10 shares, to obtain a provisional order or Act of Parliament for the construction of tramways or light railways between Cardiff and Penarth, to construct, equip, maintain and work by electricity or otherwise such tramways or light railways, and to carry on the business of tramway, railway, omnibus and van proprietors, carriers of passengers and goods, electricians, mechanical engineers, suppliers of electricity for light, heat, motive power, or otherwise, accumulator, dynamo and motor manufacturers, &c. The first subscribers (each with 10 shares) are:—J. W. Pyman, Raithwaite, Penarth, shipowner; I. Vachell, Park House, Cardiff, solicitor; D. T. Alexander, Dinas Powis, surveyor; H. Lewis, 21, Cathedral Road, Cardiff, engineer; H. Cousins, 20, Queen Street, Cardiff, engineer; J. Cory, Sea View House, Penarth, shipowner; and P. J. Tatem, Pen-y-lan, Cardiff, shipowner. No initial public issue. The number of directors is not to be less than three nor more than nine; the subscribers are to appoint the first; qualification, 10 shares; remuneration as fixed by the company. Registered office, 124, Bute Street, Cardiff.

Manufacturing Electric Co., Ltd. (78,568).—This company was registered on September 16th, with a capital of £6,000 in £1 shares (4,000 preference) to carry on the business of manufacturers of and dealers in wires, cables and lines of all kinds, electricians, electric, mechanical, gas and general engineers, manufacturers of and dealers in all kinds of apparatus used in connection with the generation, distribution, supply, accumulation and employment of electricity, &c. The first subscribers (each with one share) are:—H. N. Paisley, 34 and 35, High Holborn, W.C., solicitor; Mrs. A. B. Andrews, 2, Park Avenue, East Sheen; W. D. Driscoll, 12, Clement's Inn Passage, W.C., clerk; A. Cook, 165, Queen Victoria Street, E.C., electrical engineer; R. Hunter, 81A, Hythe Road, Thornton Heath, clerk; C. E. New, 62, George Street, Portman Square, W., architect; and H. L. Satow, 76, Clapton Common, N.E., gentleman. No initial public issue. The number of directors is not to be less than two nor more than five; the first are not named. Registered office: 34 and 35, High Holborn, W.C.

Whitehead Electric Supply Co., Ltd. (2,798).—This company was registered in Dublin, on September 18th, with a capital of £10,000 in £1 shares, to carry on the business of an electric company in all its branches, to construct, lay down, establish, fix, and carry out all necessary cables, wires, lines, lamps and works, and to generate, accumulate, distribute and supply electricity, to cities, towns, &c. The first subscribers are:—J. T. Jarvis, M.I.C.E., 28, Victoria Street, S.W., 50 shares; W. B. Cownie, 34, Victoria Street, S.W., chartered accountant, manager and secretary National Electric Wiring Co., Ltd., 50 shares; J. M. McCalmont, M.P., 625, Lower St. James Court, S.W., 50 shares; D. McNeill, The Corran, Co. Antrim, solicitor, 50 share; J. Magill, Whitehead, Co. Antrim, chartered accountant, 1 share; J. McVea, Whitehead, Co. Antrim, accountant, 1 share; and J. McLaughlin, Whitehead, Co. Antrim, 1 share. The number of directors is to be 4; the first are Col. J. M. McCalmont and Col. D. McNeill (on behalf of the local shareholders), and J. T. Jarvis and W. B. Cowrie, as nominees of the National Electric Wiring Co., Ltd.; qualification, 50 shares; remuneration, £60 per annum, divisible. Registered office:—8, Garfield Street, Belfast.

The Electro-Post Railway Co.—In our issue of September 4th (p. 393) the name of this company was incorrectly given as the *Electrical* Post Railway Co.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Chili Telephone Co., Ltd. (29,252).—This company's annual return was filed on August 8th, when 44,000 shares had been taken up out of a nominal capital of £250,000 in 50,000 shares of £5 each. £220,000 has been received. Mortgages and charges: £50,000.

Nalder Bros. & Thompson, Ltd. (62,214).—This company's annual return was filed on September 4th, when 7,846 preference and 10,725 ordinary shares had been taken up out of a nominal capital of £22,500 in 10,000 preference and 12,500 ordinary shares of £1 each. £1 per share has been called up on 7,846 preference and 725 ordinary shares, resulting in the receipt of £8,571. £10,000 is considered as paid on 10,000 ordinary shares. Mortgages and charges: *nil.*

South American Cable Co., Ltd.—This company's annual return was filed on August 24th, when 24,707 shares had been taken up out of a nominal capital of £500,000 in 50,000 shares of £10 each. £10 per share has been called up on 14,707, resulting in the receipt of £147,070. £100,000 is considered as paid on 10,000 shares. Mortgages and charges: *nil.*

E. Timmins & Sons, Ltd., electrical and general engineers, Runcorn (78,375).—A trust deed, dated August 26th, 1903, to secure £11,000 debentures, created same date, has been registered. Property charged: The company's undertaking and property, present and future, including uncalled capital and certain freehold land, mills, buildings, &c., at Runcorn. Trustees: C. E. Maples, Aughton Springs, Ormskirk, Lancs.; and A. E. Dickinson, J.P., Avening, Gloucester.

Sherard Cowper-Coles & Co., Ltd., electricians, London (67,186).—Issue, on September 11th, 1903, of a debenture bond for £50, part of series created by resolution of December 3rd, 1901, and February 7th, 1902, to secure £6,500, charged on the company's real and personal property, present and future, except uncalled capital. No trustees. Previously issued of same series: £6,175.

McGuire Manufacturing Co., Ltd., electrical engineers, London.—A charge on the lease of Elton Fold Works, Bury (subject to mortgage for £4,000), and all book debts and other moneys due, or to become due, to the company, securing £1,500 and 5 per cent. interest, has been registered. Holders: Electric Equipment and Securities, Ltd., 130, Dashwood House, Old Broad Street, E.C.

Fleetwood and District Electric Light and Power Syndicate, Ltd.—A mortgage or charge securing £950 and any further advances up to £750, created by the receiver for the debenture holders in pursuance of an Order of the Chancery Court, dated June 11th, 1903, has been registered. Property charged: All the undertaking and property of the syndicate, ranking in priority to trust deed of October 31st, 1899. Holders: W. C. Johnson, The Dignaries, Westcombe Park, Greenwich.

White, Jacoby & Co., Ltd. (52,494).—This company's annual return was filed on September 17th, when 3,207 shares had been taken up out of a nominal capital of £4,000 in 4,000 shares of £1 each. £1 per share has been called up on 850 shares, resulting in the receipt of £850. 2,357 shares are considered as fully paid. Mortgages and charges: £1,500.

Sunbeam Lamp Co., Ltd. (25,498).—This company's annual return was filed on September 2nd, when 1,765 shares had been taken up out of a nominal capital of £25,000 in 2,500 shares of £10 each. £10 per share has been called up on 908 shares, resulting in the receipt of £9,080. £8,570 is considered as paid on 857 shares. Mortgages and charges: £11,150.

India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd. (1,122 C).—This company's annual return was filed on August 17th, when 50,000 shares had been taken up out of a nominal capital of £812,000 in 81,200 shares of £10 each. £10 per share has been called up and £500,000 has been received. Mortgages and charges: £300,000.

ELECTRICITY SUPPLY ACCOUNTS.

Bolton Corporation Electricity Accounts.

The last returns of this Corporation show that the excellent working of previous years is being maintained. The revenue has not increased by so large an amount as last year; but, as the working expenses are only some £400 more, no great reduction in gross profit has resulted. From the supply output returns of the past three years, it will be seen that the increase in private lighting units shows a great falling off, and that public lighting (which, however, only comprises eight arcs) has taken less energy than in 1902. The increased output, which is nearly up to last year's increase, is made up largely of tramways and motive power supply, which, though it favours the excellent works costs here obtained, has also reduced the average price and gross revenue obtained.

Year.	Private lighting.	Public lamps.	Tramways.	Motors.	Total.	Total works cost per unit.
1901 ...	731,979	11,387	1,617,130	71,241	2,431,737	1·33
1902 ...	905,928	17,467	1,999,640	197,674	3,120,709	·96
1903 ...	968,768	10,601	2,448,290	374,939	3,802,598	·81

The working expenses have now reached the very low figure of ·81d. per unit, a reduction in the fuel item from ·44d. to ·35d. per unit, and a decrease in wages having contributed to this result.

The total capacity of plant installed amounts to 3,900 KW. The charges are:—For private lighting on the maximum demand system, 6d. and 3d., or a flat rate of 5d.; power, 2½d. to 1d.; and traction, 1·4d. per unit. Mr. A. A. Day is the borough electrical engineer.

General Statement.

Year ending March 31st—		1902.	1903.	Inc.
Total capital expended ...		£180,258	£207,482	£27,224
Number of units sold		3,120,709	3,802,598	681,889
Equivalent number of 8-c.p. lamps connected		90,057	116,323	26,266
H.P. of motors connected ...		351	925	574
Maximum load in KW.		—	2,300	—
Revenue Account.	Gross revenue ...	£29,800	£33,691	£3,891
	„ expenditure	£12,481	£12,884	£403
	„ profit ...	£17,319	£20,807	£3,488
Average price obtained	Private lighting ...	3·83d.	3·88d.	·05d.
	Public „ ...	3·90d.	3·26d.	— ·64d.
	Power supply ...	1·35d.	1·25d.	— ·10d.
	Traction „ ...	1·5d.	1·4d.	— ·10d.

Revenue Statement.

	1902. Gross.	1902. Per unit.	1903. Gross.	1903. Per unit.	Inc.
Sale of energy	£28,384	2·18d.	£32,057	2·02d.	—·16d.
Meter rents	502	·04d.	596	·04d.	·00d.
Profit on fittings and rental of motors ...	914	·07d.	1,038	·07d.	·00d.
Gross revenue ...	£29,800	2·29d.	£33,691	2·13d.	—·16d.

Cost of Production.

	1902. Gross.	1902. Per unit.	1903. Gross.	1903. Per unit.	Inc.
Coal	£5,686	·44d.	£5,641	·35d.	—·09d.
Oil, waste, water and engine-room stores	906	·06d.	943	·05d.	·00d.
Wages incurred in generation and distribution	2,568	·20d.	2,475	·15d.	—·05d.
Repairs and maintenance of engines, boilers, machinery, and buildings	1,409	·10d.	1,440	·09d.	—·01d.
Works and distribution costs	£10,466	·80d.	£10,499	·65d.	—·15d.
Rent, rates and taxes	907	·07d.	1,059	·07d.	·00d.
Management expenses, salaries of engineer and clerical staff ...	730	·06d.	898	·06d.	·00d.
General establishment charges, stationery, printing, law and insurance...	378	·03d.	428	·03d.	·00d.
Total works cost	£12,481	·96d.	£12,884	·81d.	—·15d.

In allocating the gross profit of £20,807, the department provides £5,687 for interest; £9,222 to depreciation, out of which, as in previous years, the sinking fund is taken; £975 to reserve; £4,500 in aid of the rates, and there remains a balance on the year's working carried forward of £423; making a total balance of £1,324 in hand. The total balance available for depreciation of buildings, plant, &c., amounts to £5,310. For purposes of comparison we give the usual profit statement, free from idiosyncrasies:—

Profit Statement.

	1902.	1903.
Interest on loans	£4,912	£5,687
Sinking fund	5,893	7,478
Net profit on year	6,514	7,642
Gross profit	£17,319	£20,807

Walthamstow U.D.C. Electric Supply.

The returns of the Walthamstow Electrical Department for the year ending March 31st last are well worth inspection, showing, as they do, that this borough has attained an enviable position among the local metropolitan undertakings in the matter of works costs. The following comparison will be of interest:—

	No. of units sold.	Total works costs.	Coal, &c.
Walthamstow ...	542,423	1·54d.*	·42d.
Hackney	1,614,968	1·03d.	·48d.
Stepney	1,759,349	1·23d.	·65d.
Hammersmith ...	1,736,839	2·00d.	·70d.
St. Pancras ...	4,205,050	1·88d.	·80d.
Hampstead ...	2,592,475	2·23d.	1·09d.

* Does not include cost of public lighting.

The above figures need no comment, but it will be noticed that, in the matter of fuel cost, which plays such a prominent part in Metropolitan supply work, even Hackney's excellent record, with a much larger output, is beaten, and that in spite of the fact that the Walthamstow department pays 27*s.* per ton for fuel.

The credit for these excellent results must be given to the Westinghouse gas engine plant, and to those who had the courage to brave popular engineering opinion (or prejudice?) in adopting it.

With the excellent prospect which the area holds out for motive power supply, and a tramway scheme on the way, Walthamstow stands an excellent chance of securing first place in the matter of works costs in the Metropolis and vicinity during the next few years.

The charges are:—For private lighting, 4½d. and 4d. per B.T.U., and public lighting, £7 10*s.* per incandescent and £18 per arc per annum. For power, the charges are 2½d. to 1½d. per unit. Mr. F. A. Wilkinson is the borough electrical engineer.

General Statement for Year ended March 31st, 1903.

Total capital expended		£76,447
Number of units sold—		
Private lighting		389,560
Public lighting...		152,863
Total		542,423
Equivalent number of 8-p.c. lamps connected		31,000
Number of public lamps		39 arcs 652 inc.
Maximum load		406 KW.
Revenue Account.	Gross revenue	£10,127
	„ expenditure	£3,653
	„ profit	£6,474
Average price obtained, private lighting ...		4d.
„ „ public lighting ...		4d.

Revenue Statement.

	Gross.	Per unit.
By sale of energy	£9,023	4·00d.
Meter rents, hire purchase sale and repairs of apparatus	879	·39d.
Sundry	225	·10d.
Total revenue	£10,127	4·49d.

Cost of Production.

	Gross.	Per unit.
Coal and other fuel	£948	·42d.
Oil, waste, water and engine room stores ...	527	·23d.
Wages incurred in generation and distribution	920	·41d.
Repairs and maintenance of engines and generating plant, buildings, mains, &c. ...	279	·12d.
Works and distribution costs	£2,674	1·18d.
Attendance, repairs, &c., public lamps	173	·07d.
Rent, rates and taxes	114	·06d.
Management expenses, salaries of engineer, and clerical staff	425	·19d.
General establishment charges, printing, stationery, insurance, &c.	257	·11d.
Total works costs	£3,653	1·61d.

Profit Statement.

Interest on loans	£1,563
Sinking fund	1,906
Balance carried forward	3,005
Gross profit	£6,474

The gross profit for the year amounted to £6,474, and after meeting financial charges, a balance of £3,005 remains, which, with £78 from the previous year, makes a total of £3,083 carried forward.

CITY NOTES.

Yorkshire Electric Power Co.

The first ordinary general meeting of this company was held at the Hotel Metropole, Leeds, on September 22nd. Mr. Arthur G. Lupton was in the chair. The report and accounts were adopted. It was announced that the contractors were now in possession of the land for the first power station at Thornhill, and work on the buildings was being rapidly pushed on. Tenders had been accepted for 6,000 H.P. of generating plant together with the necessary equipment for transmission and distribution. The generators are to be of the latest type of Curtis steam turbines, and are to be built at the British Thomson-Houston works at Rugby. The company are now in a position to negotiate for the supply of power within a radius of 10 miles of the first station, and power will be available in about 10 months' time. Mr. W. B. Woodhouse, engineer in charge of the generating stations at Newcastle, and at Wallsend of the Newcastle-on-Tyne Electric Supply Co., had been appointed resident engineer, and Mr. J. J. H. Stansfield, secretary; both of them were present, and would take up their duties early in October. The offices of the company are at Central Bank Chambers, Infirmary Street, Leeds. The following gentlemen were elected directors:—Messrs. Arthur G. Lupton, Robert Armitage, Arthur Currer Briggs, J. O. Callender, E. A. Carolan, H. A. Earle, A. C. Embleton, W. P. J. Fawcus, Robt. Hudson and Sir Richard Mottram.

Bury, Rochdale and Oldham Tramway Co.

The report of the directors for the half-year ended January 31st last, to be submitted at the meeting at Manchester on the 25th inst., states that the accounts show a gross profit of £2,674. The directors propose to place £500 to reserve account against depreciation, and £1,068 to debenture interest fund, which, with the sum of £37, balance brought forward, enables the payment of the fixed rate of 2 per cent. per annum, and leaves £92 to carry forward. A dividend is paid of 5 per cent. per annum, and £238 is carried forward. The aggregate traffic receipts show a decrease as compared with the corresponding half of 1902. This is accounted for by the discontinuance of running over the leased lines in Oldham, and by the competition of the Rochdale Corporation's tramways. Repairs to permanent way have amounted to £2,516 against £2,507 in the corresponding period of last year, and have, as usual, been charged to revenue account. The two valuations of the company's property mentioned in the last report were completed, and an attempt made to arrive at a price satisfactory to vendors and purchasers; but it was found impracticable, and it will therefore be necessary to resort to arbitration. Notices to purchase under the Tramways Act, 1870, have been given by several of the local authorities for certain sections within their respective districts, and Sir Frederick Bramwell, Bart., has been appointed referee by the Board of Trade. An interim working agreement was desired by the local authorities, and a number of clauses called "Heads of Agreement" were, after discussion, agreed upon and accepted in writing by both sides. The authorities have since expressed a determination not to be bound by the heads of agreement; but the board are advised that a binding contract had been entered into, and should be carried out, unless an arrangement is mutually come to for modifying or cancelling it. They have taken, and will continue to take, such steps as they deem best to protect the company's interests both as regards the working agreement and the arbitration.

Electricity Supply Co. for Spain, Ltd.

The directors' report, for the year 1902, says that the revenue has produced £31,936 15s. 8d., to which has to be added interest on deposits and transfer fees, making a total of £32,493 10s. 9d. After deducting debenture interest, interest on loans, and all charges amounting to £17,093 1s. 8d, and after putting aside £1,852 for redemption of debentures, there remains a surplus of £13,548 9s. 1d., which, with the amount brought forward from last year, leaves a balance of £22,311 4s. 2d.

After providing for the 5 per cent. dividend on the preference shares for the year 1901, amounting to £8,665, paid on February 27th last, the directors propose to write off the sum of £13,145 6s. 4d., thus entirely extinguishing the suspense account, and to carry forward the sum of £500 17s. 10d. In view of the arrangement referred to below, recently concluded for the total redemption of the first mortgage and "B" mortgage debentures in eight years, the directors do not recommend any dividend on the preference shares for this year, it being thought advisable to accumulate a reserve against any unforeseen contingency, such as a further drop in the Exchange. For this reason, the directors have, after consultation with some of the largest shareholders, decided to devote nearly the whole of the year's profits to replacing capital not represented by available assets. The shareholders may be congratulated on the greatly improved position of the company, which has enabled the directors to wipe out in two years, instead of in five, as originally contemplated, the whole of the deficiency of £19,045 on capital account as ascertained at the time of leasing the company's undertaking. In addition to this, the sum of £1,852 has been set aside for the redemption of debentures. The first mortgage debentures for £75,000 and the £41,300 "B" debentures fell due for repayment on July 1st, 1903. The state of the money market during the early part of the year rendered it inadvisable to negotiate with the holders of these two series of bonds for their conversion into 5 per cent. consolidated debentures. The directors, therefore, decided that it would be better to arrange for the extension of the first and "B" mortgage debentures for a further period of eight years, during which time the whole amount would be paid off by annual drawings. A bonus of 3 per cent. was offered to the holders agreeing to renew their bonds, and an arrangement was made with a responsible guarantor to take up and extend the holdings of those who refused. The scheme has been successfully carried through, and signed agreements have been executed in respect of the whole of the first and "B" mortgage debentures. As the company will be able practically to meet out of its income the whole of the charge for the interest and redemption of its debenture debt, the company is in a very much stronger position than it has ever enjoyed to date. It is evident that as soon as the two series of debentures have been paid off, the position of the shareholders will be immensely improved, as the sum available for dividend each year will be largely increased. The cost of carrying through the extension will appear in the 1903 accounts. Practically all the accounts owing to the company in Madrid have now been collected, and it is considered that ample provision has been made for any loss in those still outstanding.

Central London Railway Co.

An extraordinary meeting of this company was held last Friday at the company's offices in High Holborn. Sir Henry Oakley presided. He said that the ordinary capital was £2,850,000 in shares, and they had powers under two separate Acts of 1901 and 1902 to raise £150,000 share capital by each of those Acts. These Bills had been submitted to the shareholders, and the board were authorised to create the capital and to dispose of it from time to time, according to the requirements of the company, on the best terms they could obtain. At their meeting in February, he explained that the capital was in debt to the amount of £103,000, and that in the course of this half-year it would be necessary for the company to raise some of it in order to carry on their business and to pay their dividend. The capital was now all created in shares. The directors had sold £150,000, but as the whole of the ordinary share capital was now stock, and no longer shares, it was necessary that this £150,000 should be placed in the same category. The resolutions passed were as follows:—

That pursuant to the powers conferred upon the company by the Companies' Clauses Consolidation Act, 1845, the 15,000 shares of £10 each created and issued under the company's Act of 1901, all fully paid up, be converted or consolidated into ordinary stock, to be divided amongst the shareholders according to their respective interests therein. That the directors be and they are hereby authorised to raise £150,000 additional capital authorised by the company's Act of 1902, by the creation and issue of ordinary stock instead of by the creation and issue of new shares, as provided in the resolution passed at the extraordinary meeting held on the 4th day of February, 1903.

Chloride Electrical Storage Co.

The annual general meeting of this company was held at Clifton Junction, near Manchester, on Wednesday, 16th inst. The following account of the proceedings has been sent to us:—

The chairman, Mr. Bannister, in moving the adoption of the report and balance-sheet, considered that the balance-sheet was clear evidence of the prosperity of the company, and stated that the company had not alone increased their business during the year, but had also increased their profits and their favour with the public. Comparing the assets with the liabilities, the balance-sheet presented a very healthy appearance.

The vice-chairman, Dr. Hopkinson, in seconding the adoption of the report and balance-sheet, took occasion to refer to the interest which the Electric Storage Battery Co., of Philadelphia, had, during the year under consideration, acquired in the company. He did not wish any of the shareholders to have any other impression than that this move was entirely in their interests, and he had little doubt it would be greatly to their advantage in the future. It was

not an example of the American invasion of England, but an example of American co-operation with England, which could not but produce the greatest advantage.

Mr. Herbert Lloyd, who is a director of the company, and president of the Electric Storage Battery Co., of Philadelphia, pointed out that he was an Englishman born and bred; that the other director, who resided in America, was also an Englishman born and bred; and that this company was not run by Americans, but by Englishmen. It was he who had invaded America 20 years ago, and now came back with the experience of those 20 years to give the mother country the benefit of it. He stated that the Electric Storage Battery Co. in America did business last year to the extent of about £800,000 and made a profit of nearly £250,000, and that he expected the turnover of the present year would come to approximately £1,000,000. He hoped to see this company, by the adoption of their methods, largely increase its turnover, especially in the line of central station work. There was not a development which came out in America, which his company did not take up, and he considered that they should be looked upon rather as philanthropists, that, for the small interest they had here, they should give an English company so much.

Sir Bache Cunard was appointed a director of the company. A dividend at the rate of 6 per cent., less income-tax, on the preference shares, and of 8 per cent., free of income-tax, on the ordinary shares was declared.

The shareholders took the opportunity afforded them of going through the commodious and up-to-date offices which have been put up during the past year, and through the works, where they viewed with interest the manufacture of the famous "Exide" batteries for which the company has recently equipped itself. These batteries have, by several years' work in the United States, proved their superiority over all other forms of batteries for motor-car and other work, whose lightness is a specially desirable feature. The meeting terminated with a vote of thanks to the chairman and directors, and to the manager and staff.

Dick, Kerr & Co.

The directors' report for the year ended at June 30th shows that the profits amounted to £110,449. A dividend of 10 per cent. and a bonus of 5 per cent. are declared on the ordinary share capital, and £35,544 is carried forward. The directors consider the result of the 12 months' trading satisfactory, and state that the prospects for the current year show every indication of good results. The company has completed during the year under review many important contracts at home and abroad, and is still busily engaged in the execution of further large contracts. Since the last report was issued, the acquisition of the English Electric Manufacturing Co., Ltd., works in Preston has been completed, and the works are fully employed in the production of machinery for various contracts. Out of the dividends by the English Electric Manufacturing Co., Ltd., on March 31st, 1903, the sum of £30,000 has been carried direct to the credit of the reserve fund set aside under the provisions of the trust deed securing the debentures.

Stock Exchange Notices. — The Committee has appointed Tuesday September 29th, a special settling day in:—Metropolitan Electric Tramways, Ltd.—Further issue of 185,984 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 814,017 to 1,000,000. The Committee has also ordered the under-mentioned securities to be quoted in the Official List:—Eastern Extension, Australasia and China Telegraph Co., Ltd.—Further issue of £282,400 4 per cent. mortgage debenture stock. Eastern Telegraph Co., Ltd.—Further issue of £302,169 4 per cent. mortgage debenture stock. Metropolitan Electric Tramways, Ltd. Further issue of 185,984 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 814,017 to 1,000,000.

Direct Spanish Telegraph Co.—The board has decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income-tax, on the ordinary shares, both for the half-year ended June 30th, 1903, and payable on October 1st next.

Calcutta Electric Supply Corporation, Ltd.—The directors have declared an interim dividend for the half-year ended June 30th last, at the rate of 6 per cent. per annum.

Direct West India Cable Co.—The directors have declared a further dividend of 3 per cent., making 6 per cent. for the year ended June 30th last.

Halifax and Bermudas Cable Co.—The directors recommend a further dividend of 2½ per cent., making 5 per cent. for the year ended June 30th, leaving £744 to be carried forward.

Evered & Co., Ltd.—The directors have declared an interim dividend at the rate of 7½ per cent. per annum for the half-year ended June 30th last.

Hove Electric Lighting Co.—The directors recently declared an interim dividend at the rate of 7 per cent. per annum for the half-year ended June 30th last.

Folkestone Electricity Supply Co.—The directors have declared an interim dividend at the rate of 4 per cent. per annum in respect of the half-year ended June 30th last on the ordinary shares.

STOCKS AND SHARES.

Wednesday Evening.

For once in a way it may be said that the Stock Exchange is probably doing more business for investors than for speculators. Indeed, the gambling departments are all but dead; and since Capel Court is chiefly dependent upon speculation for its bread-and-butter, the cry of the average member waxes very bitter. For even the investment orders that reach the markets are few and far between. What inducement is there for people to disturb money that they have on deposit at the banks, in view of the bank rate that may have already been advanced before these lines are read? As usual, however, there is a fair amount doing in the electrical sections, and the Telegraph market, in particular, is being ransacked for cheap gilt-edged securities.

Rises of a point have been secured by Direct Spanish 4½ per cent. Debentures, Eastern Telegraph 4 per cent. Debenture stock, and Eastern and South African 4 per cent. mortgage Debenture. Singularly enough, Direct West India 4½ per cent. Debenture has declined a point. The Anglo-American Telegraph group is a little easier, although the Preferred remains quotably unchanged. Submarine Cables Trust certificates have been dealt in at 118. A further 3 per cent. dividend, making 6 per cent. for the year, is announced on Direct West India Cable shares. Direct Spanish shares are to receive 4 per cent., and there is no change in the price.

Electric railway and traction varieties are steady where other things keep dull. Central London Deferred has recovered part of its last week's fall, and we observe that one of the fashionable Society papers is adopting the line assumed in these columns that the stock will get its full 4 per cent. dividend, and that the price should go better by degrees. In markets like the present, however, it would appear as though nothing could rise, and the return of public confidence will be in no wise hastened by the political turmoil that has fallen upon the country. Metropolitans are 83 and Districts 33, while Waterloo and City is a shade lower than the official price might seem to indicate. In the prior charge list Central London 4 per cent. Debenture stock is changing hands between 115 and 116. East London Ordinary has dropped ¼ to 5.

Calcutta Tramways are a little harder at 7 middle, and the Debenture stock stands at 108. British Electric Tractions are uninteresting, and Potteries keep about 9½ and 9 for the Ordinary and Preference shares respectively. Anglo-Argentine Trams at 4¾ have disregarded the dividend of 2s. 6d. per share just declared.

In making a small Debenture issue, the Bulawayo Waterworks Co., Ltd., draws attention to its electric lighting business, and remarks that its electric light mains are laid throughout the town and suburban township for a length of 80 miles, and the light is sold at varying prices from 1s. 5d. to 2s. per unit. The company, whose principal business is, of course, concerned with the waterworks, is offering £60,000 of 6 per cent. Debentures at par.

St. James's and Pall Mall Ordinary shares came on offer the other day, and the price has been accordingly marked down ½. Beyond this the supply market has no change to show, and it is becoming quite in the ordinary course of events for this section to have no more than one or two changes on the week. The new Metropolitan Preference, now admitted to quotation in the Official List, are called 3¼—3⅜ for the £3 paid shares. The German Incandescent Gas Co. report complains that the osmium electric lamp is still far from fulfilling expectations, but the concern manages to pay a 9 per cent. dividend. Preference shareholders in the Electricity Supply Co. for Spain are somewhat disgusted at having to forego their dividend, and the meeting next Wednesday, September 30th, will give the directors a chance of saying what prospects there are for payment of the next one.

The Babcock & Wilcox interim dividend at the rate of 14 per cent. per annum has failed to exercise any effect upon the price of the shares, which still sticks at 3. Henleys have hardened 10s., and Electric Constructions are ¼ up, while the improvement in the former brought about a one-point advance in the Debenture stock. Industrials, on the whole, seem content to merely mark time. London Electric Preferences are ¼ up. National Telephone Deferred stock is a point down, although the fact becomes increasingly patent that the Post Office telephone service is almost, if not quite, as bad as that of the company. No official information is yet available with regard to the accuracy of the rumour, which declared that the tariff for telephoning to Paris is to be reduced 50 per cent.

Babcock & Wilcox, Ltd.—The directors have declared an interim dividend on the ordinary shares at the rate of 14 per cent. per annum.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Sept. 16th.	Closing Quotations Sept. 23rd.	Business done week ended Sept. 23rd, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½ — 3½	2½ — 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	6l3.	60/6	47 — 50	46 — 49	48½	46½
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	91 — 93	91 — 93	92½	92
3,105,580	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	8 — 8½	7⅞ — 8⅛	7⅞	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	6 %	4½ — 5½	4½ — 5½	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	150 —160	150 —160	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	93 — 96	93 — 96	95½	..
16,000	Cuba Telegraph	10	4½%	4 %	6½%	7 — 8	7 — 8	7⅞	..
6,000	Do. 10 % Pref.	10	..	..	..	16½ — 17½	16½ — 17½	..	..
12,981	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½ — 3½	2½ — 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	97 —101 %	98 —102 %	..	..
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½ — 10¾	10½ — 10¾	..	..
87,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,900, Red.	100	..	..	..	99 —102	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	124 —129	124 —129	127	125
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	90 — 93	90 — 98	92½	91
1,584,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	106 —109	107½	..
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	12 — 12½	12 — 12½	12 1/16	12
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	104 —107	104 —107	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	98 —101	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	100 —103 %	100 —103 %	..	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8⅞ — 9⅛	8⅞ — 9⅛	9 1/16	8⅞
180,042	Do. do. 6 % Pref.	10	..	..	..	12⅞ — 13⅛	12⅞ — 13⅛	13⅛	12⅞
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	12½%	22 — 23	22½ — 23½	22½	..
62,500£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	37 — 40	37 — 40	37½	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	97 —101	98 —102	..	..
1,988,338	National Telephone, Pref. Stock	100	5 %	5 %	6 %	100 —102	100 —102	101	100
1,966,667	Do. do. Def. Stock	100	..	..	4½%	77 — 79	76 — 78	76½	76
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
2,350,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5¼	5 — 5¼	..	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	94 — 96	94 — 96	95	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	101 —103	101 —103	102⅞	102½
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6 %	⅞ — 1	⅞ — 1	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,839	Reuter's	8	5 %	5 %	..	6¾ — 7¼	6¾ — 7¼	..	..
3,808	Submarine Cables Trust	Cert.	..	..	..	116 —121	116 —121	118	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	5¾ — 6	5¾ — 6	5⅞	5 9/16
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4¾ — 5¼	4¾ — 5¼	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	104 —107	104 —107	..	..
15,609	West African Telegraph, Shares	10	..	..	2 %	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	..	12 — 12½	12 — 12½	12⅝	12 1/16
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	100 —103	100 —103	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	99	..
88,321	West India and Panama Telegraph	10	2½%	..	..	⅞ — 1	⅞ — 1	..	..
84,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	⅛ — ¼	⅛ — ¼	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3½ — 4½	3½ — 4½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —101	98 —101	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	3 — 4	3 — 4	..	..
600,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	83 — 87	83 — 87	..	..
100,000	British Electric Traction	10	9 %	9 %	8 %	12½ — 13	12½ — 13	12⅞	12½
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11½ — 12	11½ — 12	11⅝	11½
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	122 —125	122 —125	124 3/8	124½
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	6½ — 7 xd	6½ — 7	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¼ — 5¾	5¼ — 5¾	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —106	102 —106	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	⅞ — 1	⅞ — 1	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	Nil	¾ — 1¼	¾ — 1¼	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	6 %	1 — 1½	1 — 1½	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	97 —100	97 —100	98½	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
35,000	Callender's Cable Construction shares	5	15 %	20 %	15 %	11½ — 12½	11½ — 12½	11⅞	11⅝
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼ — 5¾	5¼ — 5¾	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	106 —110	106 —110	..	..
1,960,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	97 —100	97 —100	98	97
494,098	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	99 —102	99 —102	100	..
494,998	Do. do. Def. do.	Stock	..	4 %	4 %	99 —102	100 —103	100	..
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	58 — 60	58 — 60	59½	58½
65,000	Crompton & Co., Nos. 1 to 65,000	8	8 %	7½%	5 %	2 — 2½	2 — 2½	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	100 —104	100 —104	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	2½%	Nil	..	2 1½ — 2¾	2 1½ — 2¾	..	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	77 — 82	77 — 82	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1½ — 1⅝	1⅝ — 1⅞	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2¾ — 3	2¾ — 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	98 —101	98 —101	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	9½ — 10	p 9½ — 10	9⅝	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	97 —100	97 —100	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	13½ — 14½	14 — 15	..	..
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5¼	5 — 5¼	5¼	5 1/16
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111	108 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	10 %	18½ — 19½	18½ — 19½	18½	..
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	Liverpool Overhead Railway, Ord.	10	8½%	11½	11½%	5½ — 5⅝	4½ — 5	..	..
10,000	Do. do. Pref. £10 paid	10	..	..	..	10½ — 11	10½ — 10¾	..	..
87,850	Telegraph Construction and Maintenance.	12	17½%	20 %	20 %	34 — 37	34 — 37	..	..
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	100 —103	100 —103	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	94 — 97	94 — 97	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

National Electric Free Wiring, ½—¾.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14½—14¾.
Do. do. Pref. (£10 pd.), 10—10½.

Bank rate of disc 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Sept. 16th.	Closing Quotations Sept. 23rd.	Business done week ended Sept. 23rd, 1903. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	£ 1	..	..	..	5/8 — 7/8	5/8 — 7/8	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100				118 —121	118 —121	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000	5	6 %	8 %	8 %	10¾— 11¼	10¾— 11¼	10⅞	..
20,000	Do. do. 7 % Cum. Pref.	5				10¾— 10⅞	10¾— 10⅞	..	..
150,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	10 %	9 — 9⅛	9 — 9⅛	9⅛	..
70,000	Do. do. do. 4½% Cum. Pref.	5	..	..	..	5⅜— 6	5⅜— 6	5⅜	5⅜
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	4⅞— 5	4⅞— 5	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	104 —106	104 —106	106	..
44,436	*Chelsea Electricity Supply, Ord.	5	5½%	4 %	4½%	5⅞— 6⅛xd	5⅞— 6⅛	..	..
150,000	Do. do. % Deb. Stock Red.	Stock	..	..	..	108 —111	108 —111	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	0 %	5 %	5 %	10¾— 11	10¾— 11	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	..	..	13 — 14	13 — 14	1⅜	13½
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	122 —127	122 —127	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100				102 —105	102 —105	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4 %	7⅞— 8⅛	7⅞— 8⅛	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	..	..	..	11⅞— 12⅛	11⅞— 12⅛	..	..
400,000	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red		..	..	..	109 —112	109 —113	110	109½
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	6⅞— 7	6⅞— 7	6⅞	6⅞
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6⅞— 6⅞	6⅞— 6⅞	6⅞	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock	100				107 —110	107 —110	107	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	10 %	10¾— 11⅛	10¾— 11⅛	..	..
90,000	Do. do. do. 4 % Debenture Stock	Stock	..	..	..	103 —106	103 —106	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	2 — 2⅛	2 — 2⅛	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5⅛— 6	5⅛— 5⅜	5⅛	..
250,000	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	100 —102	100 —102	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6⅓%	7⅓%	17⅞— 18⅛	17⅞— 18⅛	18⅛	18
220,000	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —113	109 —113	..	..
250,000	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	97 —100	97 —100	..	..
10,852	Notting Hill Electric Lighting	10	7 %	6 %	6 %	13 — 14	13 — 14	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14⅓%	14⅓%	14⅓%	15⅝— 16⅛	15 — 16	..	..
20,000	Do. do. do. 7 % Pref. 20,001 to 40,000	5	..	..	..	8 — 9	8 — 9	8⅜	..
150,000	Do. do. do. 3½% Deb. Stock Red	100	..	..	..	98 —101	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	21%	3⅜— 3⅝	3⅜— 3⅝	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	12½%	3⅞— 4⅛	3⅞— 4⅛	..	..
30,000	Urban Electric Supply, Ord.	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
30,000	Do. do. 5 % Cum. Pref.	5	..	..	..	5 — 5⅛	5 — 5⅛	5⅛	..
110,000	Westminster Electric Supply, Ord.	5	10½%	10½%	12 %	13 — 14	13 — 14	13⅜	13½
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6⅛	6 — 6⅛	6⅛	6⅛

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, September 23rd.

CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£20	..
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	8d.	..
a ,, Caustic (75/80%) ..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	167/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£8	..
a ,, Bichromate, casks	per lb.	2¼d.	..

METALS, &c.			
b Aluminium Ingots, in ton lots ..	per ton	£190	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
p Babbitt's metal ingots	per ton	£43 to £135	dec.
c Brass (rolled metal 2' to 12') basis	per lb.	7d.	..
c ,, Tube (brazed)	per lb.	8¾d.	..
c ,, ,, (solid drawn) ..	per lb.	7¾d.	½d. dec.
c ,, Wire, basis	per lb.	7¾d.	..
c Copper Tubes (brazed)	per lb.	9d.	½d. dec.
c ,, ,, (solid drawn) ..	per lb.	9½d.	½d. dec.
g Copper Bars (best selected) ..	per ton	£71	£4 dec.
g Copper Sheet	per ton	£71	£4 dec.
g ,, Rod	per ton	£71	£4 dec.
e ,, (Electrolytic) Bars ..	per ton	£67	..
e ,, ,, Sheets ..	per ton	£77	..
e ,, ,, Rod ..	per ton	£69	..
e ,, ,, H.C. Wire	per lb.	8¼d.	..
f Ebonite Rod	per lb.	3/6	..
f ,, Sheet	per lb.	3/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	3/-	..
h India-rubber, Para fine	per lb.	4/8	inc.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	45/1½	9½d. dec.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£11 7 6 to £11 10	2/6 dec.
g ,, ,, Sheet	per ton	£18	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 7 6	..
d Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d ,, ,, ,, medium	per lb.	2/6 to 3/9	..
d ,, ,, ,, large ..	per lb.	4/- to 7/9	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/2	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£120 to £121	£2 dec.
g ,, Foil	per lb.	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/7	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5½d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	11½d.	..
j ,, 10 lbs. Russian, single ..	per lb.	11d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£24 5	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons, Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Hill & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

	Locality.	Week ending	Receipts for the week. £	£*	Total to date. £	£*	Miles open. *	
	Aberdeen	Sep. 19	1,165	+161	21,176	+ 2,712	10	—
	Birmingham	,, 19	5,095	+144	192,116	+ 8,488	—	—
	Bournemouth	,, 19	1,147	—	—	—	10½	—
	Blackburn	—	—	—	—	—	12½	+1½
	Blackpool	,, 17	1,590	— 21	30,649	— 140	8½	—
	Blackpool and Fleetwood	,, 19	1,082	— 62	16,809	— 109	7½	—
	Bolton	,, 20	1,8 4	+226	47,4 6	+ 6,321	25	—
	Bradf rd	Aug. 23	4,267	+579	81,276	+13,000	41	+4
	Brighton	Sep. 20	965	— 13	39,181	—	6½	—
	Bristol	,, 18	4,894	— 73	—	—	28	—
	Burnley	,, 19	861	+175	—	—	7½	—
Brit. Elec. Trac. Co.	Barnsley District	,, 11	184	—	6,612	—	4½	—
	Devonport	,, 11	521	+ 20	16,350	+ 421	5	—
	Dudley—Stourbridge..	,, 11	934	+ 28	30,567	+ 8,011	18½	—
	Gateshead	,, 11	925	+ 51	31,485	+ 4 592	10½	+ ¾
	Gravesend—Northfleet	,, 11	297	+ 62	8,750	+ 639	3½	—
	Greenock—Pt. Glasgow	,, 11	560	— 50	19,924	+ 1,450	7½	—
	Hartlepool	,, 11	309	+ 13	9,908	+ 401	6½	+2
	Kidderminster	,, 11	141	— 12	4,819	+ 186	4½	—
	Merthyr	,, 11	219	+ 15	7,234	— 229	3	—
	Middleton	,, 11	341	+ 35	11,992	+ 1,486	8½	—
	Oldham—Ashton ..	,, 11	590	—101	20,947	+ 1,446	8	—
	Peterborough	,, 11	166	—	5,968	—	—	—
	Poole	,, 11	398	+ 40	11,297	+ 1,724	8½	—
	Potteries	,, 11	1,705	+ 78	56,498	+ 3,096	29½	—
	Rothesay..	,, 11	154	— 46	5,994	+ 1,100	2½	—
	Sheerness	,, 9	86	—	2,162	—	2½	—
	Southport	,, 11	379	+ 42	11,642	+ 2,060	6½	—

* Compared with the corresponding period of 1902.

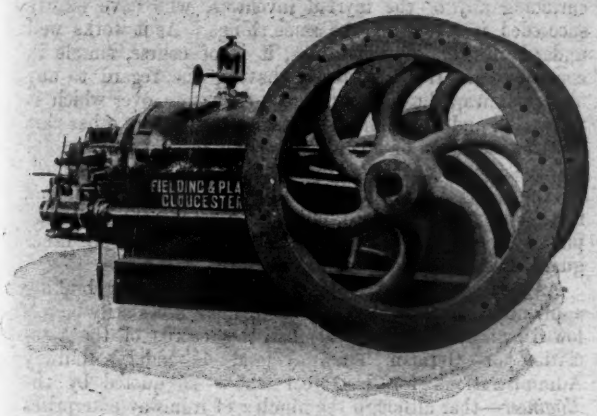
	Locality.	Week ending	Receipts for the week. £	£*	Total to date. £	£*	Miles open. *	
	South Staffordshire ..	Sep. 11	1 091	+855	32,485	+ 4,890	21½	—½
	Swansea	,, 11	574	+ 88	19,060	+ 1,641	5½	—
	Taunton	,, 11	62	— 14	2,259	— 214	1½	+½
	Tynemouth	,, 11	488	+ 12	12,018	+ 962	3½	—
B.E.T. Co.	Weston-super-Mare..	,, 9	228	— 61	4,808	— 478	2½	+½
	Wolverhampton Dist.	,, 11	896	+ 57	14,311	+ 6,915	10½	+8
	Wrexham	,, 11	137	—	3,379	—	—	—
	Yorks. Woollen Dist..	,, 11	486	—	10,278	—	6	—
	Cardiff	,, 19	1 997	+417	50,255	+15,061	14	—
	Chatham & District Co.	,, 17	596	+ 61	19,895	+12,682	8·53	—
	Dover	,, 19	259	+ 7	8,589	+ 57	3	—
	Dublin	,, 18	4,811	+105	66,516	+ 6,256	46½	+ ½
	East Ham	,, 19	708	+182	17,489	+ 5,367	6	+ ½
	Glasgow	,, 19	14,568	+1632	216,953	+23,598	66	+ 9
	Hull	,, 19	1,80	+ 94	45,787	+ 2,154	11	+ 1
	Ilkeston	,, 6	163	—	—	—	4	—
	Isle of Thanet	,, 19	1,050	—215	28,087	— 1,455	10½	—
	Leeds	,, 19	5,498	+265	142,101	+ 8,134	41	—
	Liverpool	,, 12	10,566	+136	371,077	+11,763	100	—
	Manchester	,, 19	11,781	+6856	206,127	+184 8.8	72	—
	Newcastle	,, 19	3 996	+464	—	—	17	—
	Portsmouth	,, 19	1,923	+ 92	—	—	22	—
	Salford	Aug. 24	2,856	+1135	79,460	+24,703	30	—
	Southampton	Sep. 17	1,060	— 48	—	—	9	—
	Sunderland	,, 20	1,884	+713	32,722	+ 1,645	20	+3
	Central London Railway	,, 19	5,900	—424	72,965	— 2,972	6	—
	City and S. London Ry.	,, 20	2,482	— 209	29,388	— 3,827	6½	—
	Dublin and Lucan Elwy.	,, 20	182	— 1	1,761	+ 84	6½	—
	Liverpool Overhead Ry.	,, 20	1,600	+176	30,596	+ 1,264	6	—

THE GAS ENGINE AND ITS FUTURE.

(*Concluded from page* 478.)

Fielding Gas Engine.

The "Fielding" gas engines, manufactured by Messrs. Fielding & Platt, Ltd., Gloucester, are of the horizontal and vertical types. The horizontal single-cylinder engines are made in powers up to 300 B.H.P., while the vertical four-cylinder engines are capable of developing up to 750 B.H.P.



Fielding Type: Fig. 1.—Horizontal Engine.

with retort gas, with a maximum piston speed of 900 ft. per minute. With the four-cylinder engines the supply of gas and air is controlled by a piston valve actuated by the governor, which cuts off the gas and air proportionately. The cycle in both the horizontal and vertical engines is the Otto four-cycle.

The vertical multi-cylinder engines, having enclosed crank chambers, are largely self-lubricating, while owing to their efficient balancing, vibration is reduced to a minimum.

This firm supplies the gas-producer plant, as well as a "self-starter" on a patented principle, so that it is prepared to undertake complete installations for the driving of dynamos.

Fig. 1 shows the single cylinder horizontal type up to 300 B.H.P., while fig. 2 illustrates the four-cylinder vertical type up to 750 B.H.P.

From the numerous examples now on the market, it will be noticed that the Otto four-cycle type is still mostly preferred, and a study of the different engines described will give the explanation. Engines built on the Otto four-cycle principle are capable of giving a thermal efficiency of from 25 to 30 per cent.; but it will be noticed that the two strokes in which there is no pressure in the cylinder—*i.e.*, the operations of discharging the products of combustion and drawing in the new charge—are performed by the movements of heavy machinery—viz., the trunk piston, connecting rod, &c. Where the cyclic regularity is not of great importance, this type of engine gives very satisfactory results, as large cylinder area can be adopted with the maximum of simplicity in regard to the details of the machine. However, the necessity for a minimum of cyclic irregularity associated with as compact an engine as possible, has induced gas engine builders to carry out the two almost non-pressure strokes in separate cylinders, so as to bring down the first cost of the machine.

To obtain the necessary cyclic regularity required for driving alternators, two methods are open—either to have a number of cylinders grouped round the crankshaft, so that the impulses are frequent, or to increase the number of impulses in the cylinder employed.

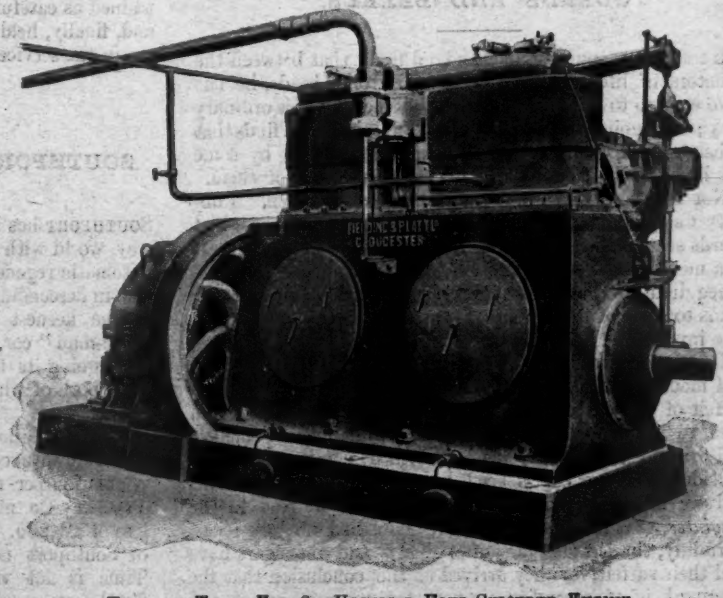
The first method entails a considerable capital outlay, so that the two-cycle engine has been resorted to by some makers. The Otto four-cycle principle does not require the gas to be delivered to the engine under any considerable pressure, so that the risk of gas leakage is reduced to a minimum; the two-cycle and other methods, which depend upon the gas being delivered under pressure to the main cylinder, increase the liability to the leakage of a highly poisonous gas, not readily detected by smell. However, it must be pointed out that there is not any great possibility of a serious leak occurring.

Those systems which deliver the gas under pressure to the main cylinder while the exhaust valve is open, or, as it might better be expressed, before the exhaust valve has closed, are liable to permit a portion of the gas to escape through the exhaust valve, but as the gaseous fuel is so low in value compared with natural or retort gas, the improvement in the regular running of the engine counterbalances this defect.

As will have been noted, some makers prefer to retain the Otto four-cycle, but make the cylinders double-acting.

While the large gas engine has been developed by British and Continental engineers, we have a further instance of the great enterprise of Americans when they are convinced that they have got hold of a good thing. We refer to the installation of gas engines at the works of the Lackawanna Steel Co., at Buffalo.

Though the Westinghouse Machine Co. only completed the first large gas engine in that country in 1899, which was one of 650 H.P., the Lackawanna Co. have already started the first of eight 1,000-H.P. Körting gas engines, which are to be driven by blast furnace gas, and used for driving electric generators direct coupled; the complete installation includes 16 2,000-H.P. blast furnace gas engines of the same type, but these are to be used for blowing purposes. A description of the engines appeared in *Machinery*, January, 1903. These are by no means the only gas engines of large power now in operation or building in the United States, as engines of 1,000 or more H.P. have been made by the Snow Steam Pump Works, Buffalo, the De La Vergne Refrigerating Machine Co., New York, the Westinghouse Machine Co., and others; our object in quoting these large installations is to indicate the confidence the gas



Fielding Type: Fig. 2.—Vertical Four-Cylinder Engine.

engine is inspiring in its economical, satisfactory, and reliable qualities, developed in the short space of a few years.

We give below the dates of some of our issues which have included articles relating to this subject:—

"The Utilisation of Blast-Furnace Gas in the Generation of Electricity," December 14th and 22nd, 1899.

"The Utilisation of High Furnace Gases for Power in Gas Engines," December 29th, 1899.

"The Utilisation of Blast-Furnace Gas for the Development of Power by Gas Engines," April 27th, 1900.

"Blast Furnace Gas Power Installation," December 14th, 1900.

"Practical Considerations Involved in the Generation of Power by Blast-Furnace Gas," December, 1900.
"Power Gas and Large Gas Engines," January 25th, February 1st, and February 15th, 1901.
"The Dynamo as an Adjunct to the Blast Furnace," January 3rd, 1902.
"Motive Power from Blast-Furnace Gases," January 17th, 1902.
"Electric Power from Blast-Furnace Gas," September 12th, 1902.
"Blast-Furnace Gas Power," September 12th, 1902.
"A Study of Power Gas," October 31st, 1902.
"Recent Progress in Large Gas Engines," October 24th, 31st, and November 14th, 21st, 1902.
"Gas Engines for Central Stations," December 19th, 1902.
"The Use of Blast-Furnace Gas in Gas Engines," January 29th, 1903.

The following articles on modern gas engine installations have appeared in our issues :—

"Northwich Electricity Works," February 1st, 1901.
"Walthamstow Electricity Works," October 18th, 1901.

We may also mention a paper on—

"Ignition and Ignition Gears for Internal Combustion Engines," by H. Mensforth, before the Sheffield Engineering Society, *Mechanical World*, May 9th, 1902.

As indicating the dimensions of large gas engines, we give the following table, but of course there are other more important considerations entering into the question of the driving of alternators, &c. :—

Comparative Weights of Gas Engines.*

Type.	B.H.P.	Approximate overall length in feet.	Approximate overall breadth in feet.	Approximate weight including fly-wheel.
Körting	400	30	18	50 tons
Gasmotoren-Fabrik Deutz	500	44	18¾	119 „
Cockerill single cylinder	600	—	—	125 „
Körting	700	41	23	127 „
„	1,000	49	29	190 „

* R. M. Neilson, the *Mechanical World*, March 6th, 1903.

THE RELATIVE IMPORTANCE OF LIFE-GUARDS AND BRAKES.

The tramways engineer in England finds that between the inventors of lifeguards, dry seats and trolley heads, he has quite enough to occupy him without attending to his ordinary work ; and, going to the Tramways Exhibition, he finds that he has to walk warily to avoid being snapped up by some new lifeguard in operation. Altogether he is sick of them.

Not so the three tramway authorities of Dresden. Publicity was given recently to their offer of prizes for the best guards sent to them. The German lifeguard inventor must be a modest and retiring individual. In England no prize is required to drag the genius from his den ; in fact, it seems to some of us that a prize should be given to the man who invents the least number of lifeguards in any year.

Dresden called the whirlwind, and it duly arrived with 454 models and drawings! After all, if one must have a surfeit of any device, it is better to have it all at once, and then to ban it for ever. Out of that multitude of models and drawings, seven only were selected by the jury as worth considering. Our experience led us to anticipate that result, and we manifested no astonishment when we read in the *Engineer*, that in those seven were embodied no new ideas. Certainly, the Dresden jury of engineers and managers have had their surfeit, for they arrived at the conclusion that the lifeguard is of secondary importance to a powerful and reliable brake in the hands of a well-trained driver, while they desire to see the under-side of the platform cleared of all parts that are low enough to strike any unfortunate who has fallen in front of the car. That is one of the suggestions lately made by the Board of Trade, and a good one it is, although it may be an expensive matter to make the necessary alterations on the older cars, as it involves exchanging the fixed step for a folding step interlocked with the gate, which will hardly be done on any but cars yet to be built, and not then, unless the Board of Trade inspectors frown very heavily.

Of course, the Dresden people are quite right in making the strongest point of a powerful and well-applied brake, but there are, alas, too many cases in which the most perfect brake, controlled by an ideal motorman, would be useless alone to prevent personal injury. In such cases the safety of the individual under the platform *must* depend on the efficiency of the lifeguard, and, as everyone knows, it is possible to make or to buy quite cheaply a guard of the trigger, or advance gate type, which is as certain in operation as any guard is ever likely to be. For about £4 per car the guard we have in mind can be made and fitted, without enriching any of the myriad inventors, who have mostly succeeded in patenting the same things. As it works well under hard tramway conditions, it is, of course, simple in construction. If set correctly (having due regard to any abnormal inequalities of surface on the route over which it will pass), and if examined occasionally, like any other part of the mechanism of a car, its action is prompt and certain, and the cost of upkeep—so heavy with many of the guards on the market—is small. All this is interesting if you must have a trigger-guard, but, to our minds, the Liverpool plough-guard fulfils the essential conditions as no other guard does at the present time.

As tending to bear out the statement that better braking appliances, and highly trained men, must necessarily be followed by a decreased casualty list, the records of the Association of German Tramway and Secondary Railway Administrations for last year show—as quoted by the *Engineer*—that although the number of tramway enterprises included in the return has risen from 110 in 1901 to 117 in 1902, the car-kilometres run have increased by 22 millions, and the passengers carried have increased by 29 millions, the serious accidents have decreased from 703 in 1901 to 636 in 1902, the reduction being made chiefly in fatal accidents. It may be that as the number of cars in the streets increases, so the foot-passenger becomes more cautious, and children are more carefully watched and specially warned of the danger of playing near tramlines, in which case we should not look for accidents to increase in the same ratio as the increase of traffic ; but we are inclined to agree with the Association that the best part of the reduction can be assigned to brakes and brakesmen.

No English line can hope to make a similar reduction in its casualties unless the men, first of all, are picked ; then trained as carefully as the importance of their duties demands and, finally, held with a firm grip of discipline while they are in the service.

SOUTHPORT ONE-MAN ELECTRIC CAR.

Southport has lately become quite as famous in the tramway world with its "one-man" car as Devonport with its automatic regenerative control, which returns energy to the line in descending hills.

The keenest interest is taken in the new "demi" or "one-man" car, which, during the last few weeks, has been undergoing its trial and Board of Trade inspection at Southport, both of which have now been brought to a successful close.

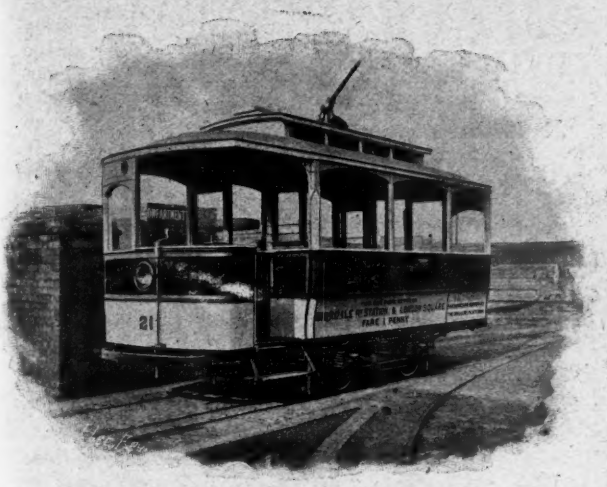
The population of Southport and Birkdale is 61,000, and the tramways cover 17 miles of route, equal to 3,600 of population per mile ; nevertheless, last year the Southport Tramway Co. made a loss of £2,000, and the Corporation a loss of £1,200. This may be due to the fact that the case of Southport is peculiar, and requires peculiar remedies. Time is not valuable to the majority of the residents in Southport, so many people walk for exercise, and save their pennies. The result is that the luxurious electric cars may at some times be seen running with only three or four passengers.

To get over this difficulty, the "one-man" car, to which we have called attention lately, has been designed by Mr. J. S. Raworth, the chairman of the Southport Tramways Co., for use on lines which at certain periods of the day or year cannot support the comparatively high working expenses of a full-sized car. It weighs about 4½ tons, has seating capacity for 20 passengers, and is fitted with hand and electric brakes and brush lifeguards.

It is constructed so that one man (the driver) can

perform all the duties necessary for working the car, thus dispensing with the conductor's services. Passengers enter by the driver's platform, and put their fares in a box. The rear step is folded up and locked by the gate.

Between the part of the platform occupied by the driver, and the entrance to the body of the car, is a bar, which, on being lifted to admit passengers, temporarily cuts off the



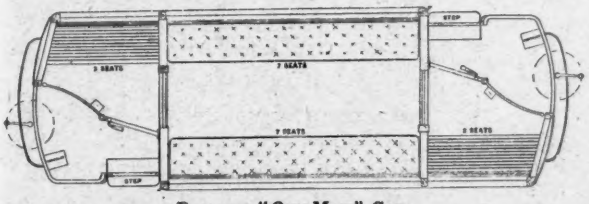
"One-Man" Electric Car.

current, or in the event of the driver becoming incapacitated, and anyone going to his assistance, the lifting of the bar stops the car.

The car cannot be started until the gate is closed.

The controller handle moves with the force of one finger, and every position of the handle agrees with a certain speed of the car. The forward position gives full speed, and the backward position, no speed. Therefore, to stop the car it is necessary only to pull back the handle.

The equipment consists of one Brush 800 C motor, the fields of which have been specially wound to suit the control, which is on the regenerative system. Although the line at Southport is practically level, this system of control



Plan of "One-Man" Car.

has been adopted on account of the ease and perfection of manipulation which it affords. The range of speed varies from 4 to 17 miles an hour.

At each end of the car is a smoking compartment, where three persons can sit.

From a large number of trial runs the mean consumption of energy as measured on the car, appears to be 0·28 unit per car-mile. This energy consumption is not exceptional, considering that the present large cars of the company (carrying 56 passengers) absorb only ·55 unit per car-mile.

The actual running cost per car-mile of the car is estimated as follows:—

Energy, 0·28 unit at 2d.	...	...	...	= 0·56d.
Labour, one man at 1d.	...	...	...	= 1·00d.
Repairs	...	...	...	= 70d.
				2·26d.

It will therefore be seen that this car will enable a company to run a much more frequent service on lines which at present can hardly maintain a 15 or 20 minutes' service, and will bring the benefits of electric traction to some districts which without it could not profitably be served.

It has been estimated that the use of these cars during the slack periods of the day and year would go a long way toward converting the losses of last year into profits for both the Southport company and the Corporation.

Fig. 1 is a plan showing the general arrangement of seating accommodation, locking gear, &c.; fig. 2 is from a photograph of the car.

MOTOR-GENERATORS AND ROTARY CONVERTERS.

By H. M. Hobart.

A synchronous motor in a sub-station will, of course, have the same percentage speed regulation as the central station generators from which it is supplied. Consequently a continuous current generator directly driven by it, is in all respects the equivalent of a continuous current generator direct connected to an engine with this percentage speed regulation. It may be shunt-wound, or it may be compounded for constant terminal voltage at all loads, or for a voltage increasing with the load. The amount of loss in the high-tension transmission line has no influence upon its operation. One may, and in long-distance transmissions must, from economical considerations, have 20 per cent. voltage drop, or even higher, in the high tension line, and yet may have just as perfect voltage regulation at the commutator of the continuous current generator as could be obtained with 5 per cent. drop or less. Thus, in a case where motor-generators are employed, one will expend just so much for transmission cables as to obtain maximum economy when estimated on the basis of the interest on this capital outlay for cables and the cost of producing the energy dissipated in the transmission line. But when rotary converters are used, it becomes practically impossible to obtain satisfactory automatic control of the commutator voltage with more than from 5 per cent. to 10 per cent. resistance drop in the high-tension line, and a thoroughly excellent result is only to be obtained by a very low resistance drop. Hence a successful plant with rotary converters in the sub-stations only becomes economically possible where the length of transmission is not great, or where a higher voltage is employed for transmission than would be required for the operation of motor-generators. Although these considerations have not heretofore been so prominently emphasised in comparing the two systems, they corroborate the generally accepted view that the use of rotary converters is attended with higher efficiency in operation than is the case where motor-generators are used. But they are at variance with another generally accepted conclusion, namely, that a lesser first cost may be attained by the use of rotary converters. This may sometimes be the case for short distances, but for other conditions the greatly increased outlay necessary for cables will generally lead to the opposite result. Thus the question resolves itself—for any given case—into comparing the greater interest on capital expenditure when rotary converters are used, against the cost of operation with motor-generators. For conditions where this comparison shows little to choose between the two systems, motor-generators should be employed on the score of their great superiority in convenience of operation. In order to demonstrate the soundness of this position, the properties of these two types of apparatus will be examined.

Consider the case of a hypothetical synchronous motor and transmission system for which the following assumptions would hold:—

1. No reactance in armature.
2. No resistance in armature.
3. Constant voltage at collector rings.

The phase characteristics of such a motor would resemble the curves of fig. 1, where a given constant field excitation corresponds to minimum current input for all loads, *i.e.*, to unity power factor.

Suppose next that assumptions 2 and 3 still hold good, but that the armature has reactance. In proportion to the magnitude of this reactance the curve of field excitation for unity power factor will bend toward the right, as shown in fig. 2.

Should, on the other hand, assumptions 1 and 3 hold good, but should allowance require to be made for the

resistance of the armature windings, fig. 1 would be modified in the manner shown in fig. 3, the curve of field excitation for unity power factor sloping to the left.

If, instead of the third assumption to the effect that there is constant voltage at the armature terminals of the synchronous motor, there is a drop of voltage in the line proportional to the load on the motor, the curve will be modified in the same way as by resistance drop in the armature, and the slope to the left will be greater the greater

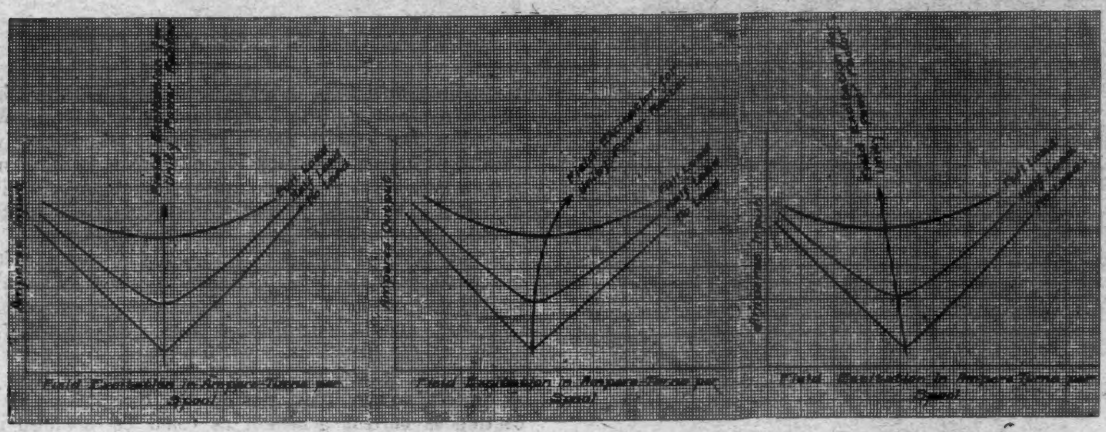


Fig. 1. Fig 2. Fig. 3.

the line drop. If the arrangements should be such that the terminal voltage increased with the load, the effect would be to reduce the slope to the left occasioned by the armature resistance, or, with sufficient rise in terminal voltage, to bring the line back to the vertical, or even to swing it over to a slope to the right. Now, when a continuous-current generator is directly driven from such a synchronous motor, the commutator voltage, according to the method of excitation, may automatically decrease, remain constant, or increase with the load, and this source may be employed for the excitation of the synchronous motor. The net result from these considerations is that we may readily arrange, if necessary, by series coils in addition to shunt coils* for a synchronous motor to be automatically excited with field currents suitable to secure practically unity power factor at all loads. This is the condition for a minimum loss of energy in the high-tension transmission line, and for a minimum outlay for copper.

We may illustrate this by a practical case. Let a three-phase synchronous motor be direct connected to a continuous current generator of 800-kw. rated output, compounded for a terminal voltage of 500 volts at no load, and 525 volts at full load. At 89 per cent. combined efficiency for the set, the synchronous motor will absorb

$$\frac{800}{0{\cdot}89} = 900 \text{ kw. at full load.}$$

The motor has an external stationary armature with Y-connected windings, fed over a three-core cable direct from the central station, no other apparatus being supplied from this cable. The central station voltage is maintained constant at 5,800 volts, and at full load of the synchronous motor at unity power factor, the drop in transmission line plus armature resistance, is 10 per cent. per phase, the voltage at the motor (considering the armature resistance to be transferred and added to the line) thus falling from 5,800 volts at no load to

$$5{,}800 \times {\cdot}90 = 5{,}200 \text{ volts}$$

at full load.

The voltage per phase in the armature is

$$\frac{5{,}800}{1{\cdot}73} = 3{,}350 \text{ volts at no load,}$$

and

$$\frac{5{,}200}{1{\cdot}73} = 3{,}000 \text{ volts at full load.}$$

The current per phase is thus

$$\frac{900{,}000}{3 \times 3{,}000} = 100 \text{ amperes at full load.}$$

Let the slots and windings be so proportioned that at 100 amperes, the reactance voltage per phase is 1,000 volts, and let the combined armature strength of the three phases amount to 4,200 maximum ampere-turns per pole. Let the field excitation required for 5,800 terminal volts at no load, equal 7,000 ampere-turns per pole.

The first step is to find the field excitation corresponding to 100 amperes per phase at unity power factor and 5,200 terminal volts.

We will take into account the saturation by estimating the *no load* ampere-turns for 5,200 terminal volts, at

$$\cdot 96 \times \frac{5{,}200}{5{,}800} \times 7{,}000 = 6{,}000 \text{ ampere-turns.}$$

The armature demagnetisation, at 100 amperes and unity power factor, amounts to

$$\sin\left(\tan^{-1}\frac{1{,}000}{3{,}000}\right) \times 4{,}200 = {\cdot}32 \times 4{,}200 = 1{,}350$$

ampere-turns.

Hence at full load of 100 amperes input, and 5,200 terminal volts, the excitation required for unity power factor would be

$$6{,}000 + 1{,}350 = 7{,}350 \text{ ampere-turns;}$$

and to obtain approximately unity power factor from no load to full load, the field excitation should automatically increase from 7,000 to 7,350 ampere-turns per pole, that is, by 5 per cent.

This corresponds to the over-compounding provided for the direct-connected continuous-current generator (500 volts at no load up to 525 volts at full load), hence the excitation of the synchronous motor may be provided from that source, and an automatic control of the power factor at approximately unity will be obtained for all loads. Of course it is by no means necessary to obtain so close an agreement, since a very considerable deviation from the correct excitation will not occasion more than 1 or 2 per cent. deviation from unity power factor. It is evident that by designing a synchronous motor with suitable armature inductance, armature strength, resistance and degree of saturation, it may be arranged for automatic operation at practically unity power factor for any reasonable value of line drop and over-compounding of the continuous-current generator which it drives.

Although the constants of the synchronous motor used for illustrating this explanation, were chosen at random and are in no sense put forward as representing an ideal or even carefully considered design, it may be of interest to plot its estimated phase characteristics when operated under the conditions set forth. These are given in fig. 4 for no load, half load and full load. The curve passing through the minimum points corresponds to unity power factor, but excitations corresponding to any part of the shaded area shown, will give at least 0·99 power factor, thus permitting at full load a total range of variation of the excitation, of about 20 per cent., so that it would not be worth while to

* In the few cases where a compound-wound synchronous motor would be necessary, the armature would have to be of the internal revolving type.

modify the design of the synchronous motor for the sake of obtaining better conditions in this respect, even for very different line constants, or requirements as to over-compounding of the continuous current generator.

The characteristic curves of fig. 4 were estimated on the basis of the armature's magnetomotive force being equivalent to that of the field spools in the proportion of

1 root-mean-square ampere-turn per pole per phase,

representing a resultant armature strength per pole capable of replacing

$$1 \times \sqrt{2} \times 2 = 2{\cdot}83 \text{ ampere-turns per field spool,}$$

this being a proportion experimentally verified by an analysis of 14 three-phase machines of a wide range of

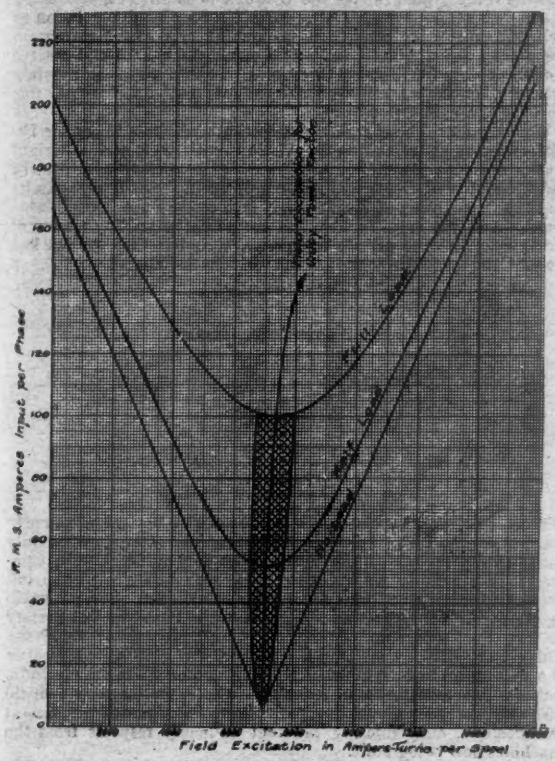


Fig. 4.

designs, and out of which the values for all but one fell within 12 per cent. above and below this mean value.

It should not be necessary to follow up this investigation any further, so far as concerns demonstrating that, with any line loss that could be economically permitted, synchronous motors with automatic control for high power factor may be satisfactorily employed to drive continuous current generators, which latter, with any range of compounding within customary requirements, may serve as supply for the synchronous motor's field excitation.

It will now be demonstrated that, with rotary converters, a very different state of affairs exists in this respect.

First, an examination must be made into the magneto-motive force exerted by the armature currents in a rotary converter. With the customary windings for three-phase synchronous motors, the armature coils are so broad in proportion to the breadth of the pole face, and those corresponding to any one phase are so situated with respect to one another, that nearly the entire flux set up by the field spools and emanating from the pole face, is simultaneously and completed linked with the total number of turns per armature coil per phase. But in rotary converters this is not the case, for as may be seen from fig. 5, the conductors of a single phase are spread out over two-thirds of the polar pitch, and only that small portion of the total flux which enters the armature through the intervening one-third of the polar pitch is simultaneously linked with the total number of armature turns. For this reason it follows that a given number of ampere-turns in the field spool are much less effective in setting up lines, which shall become linked simultaneously with the armature turns of any one phase, than is the case with the windings customarily employed in synchronous motors.

An analysis of the observed no-load phase characteristic curves of 12 three-phase rotary converters of a wide range of ratings with respect to the outputs, speeds, periodicities and voltages, yielded as an average result for estimating the effectiveness of the armature magneto-motive for replacing the field magneto-motive force, the following rule :—

"When in a rotary converter the magneto-motive force is derived from the armature winding itself, in virtue of the wattless component of the alternating current entering the

Diagram of relative arrangement of the armature conductors in the three phases A, B and C of a three-phase rotary converter. The overlapping of these phases is to be noted.

Fig. 5.

armature, a root-mean square (R.M.S.) value of the armature ampere-turns per pole-piece per phase, represented by 1·00, equals in effectiveness a field excitation of 4·30."

Thus, with such a distributed three-phase winding, and the pole breadths customarily employed in rotary converters, the magneto-motive force of the field spools is, in practice, but 63 per cent. $\left(\frac{2{\cdot}83}{4{\cdot}30} = {\cdot}63\right)$ as effective as with the normal three-phase winding and the pole breadths employed in synchronous motors.

For so-called six-phase rotary converters a constant intermediate between the values of 2·83 and 4·30 should be

Diagram of relative arrangement of the armature conductors customarily employed in the three phases A, B and C of a three-phase rotary converter. Also corresponds to the relative arrangement in a three-phase rotary converter with six slip rings, generally called a "six-phase rotary converter."

Fig. 6.

obtained, for the armature winding per phase is then distributed over but one-third of the surface, as shown in fig. 6, thus being equivalent in this respect to a three-phase-wound synchronous motor, although still handicapped by the general practice of employing greater pole breadths in rotary converters. It must, however, be stated that an analysis of the small amount of experimental data available on rotary converters with six slip rings, failed to reveal this difference; in fact, the magneto-motive force relations appeared to be the same as for rotary converters with three slip rings, and, pending sufficient experimental data to the contrary, should be so taken.

The expression "six-phase rotary converter" is slightly misleading. It would be better described as a three-phase machine with six slip-rings. For the purpose of this discussion it is immaterial whether it is distinctly kept in mind that the machine has six rings, and it will be convenient to denote by Y current, the current equivalent to one branch of the Y in a Y-connected synchronous motor of the same capacity and voltage.* Similarly, by Y voltage will be denoted the voltage from the common connection to any one terminal of such an equivalent synchronous motor.

The arrangement of the armature slots and windings, and the general proportions of a rotary converter, are such that it has a comparatively small reactance, and in the following investigation the effect of the reactance has been neglected in the interests of simplifying the necessarily very tedious work. The conclusions are not thereby appreciably affected.

(To be continued.)

* In the case of a rotary converter with three slip rings, this is the current per slip ring; for the case of six slip rings, it is twice the current per slip ring. In both cases the alternating current component of the total current per armature conductor is equal to this Y-current divided by $\sqrt{3}$ and by the number of poles, for a multiple-circuit single winding, or by 2, independently of the number of poles, for a two-circuit single winding.

THE EVIDENCE ON MUNICIPAL TRADING.

(*Continued from page* 483.)

The facts submitted to the Committee by Mr. Arthur Kay, J.P., with reference to the trading and financial arrangements of the Glasgow Corporation, are of the utmost interest. He represented a very powerful body of ratepayers, known as the Ratepayers' Federation, which possesses a guarantee fund for fighting against the trading schemes of the Corporation, an example which we commend for general adoption.

The value of Mr. Kay's evidence is increased by the entire absence of personal feeling, or any attempt to question the *bonâ fides* of the Corporation. He deals with a system which he proves to be utterly at variance with the principles which should govern the corporation of a city, whose duty, as originally ordained, was to administer public affairs, to look after the health of the population, to police the population, to cleanse the town, and so forth, and not to embark in all kinds of trading operations, which it is neither politic nor possible for them to undertake with success. The financial arrangements of the Corporation are entirely out of harmony with the generally understood practice of local authorities.

Of course, it is known that one of the objections—and not the greatest, by any means—to municipal trading is the fact that the members of the Councils do not necessarily possess any knowledge of the business undertaken, and must borrow the required capital, paying interest upon it whether remunerative or not, but it is also understood that an invariable condition of the loans is their repayment by sinking fund within a certain period.

Mr. Kay proves that the total debt of Glasgow amounts to the respectable sum of 13 millions, of which about two millions is invested in the tramways, which are entirely financed on open account. "Surely," said Sir George Bartley to the witness, "they pay them (the loans) off to somebody?" and Mr. Kay replied: "No, they do not pay them off at all: they simply use the money to reduce the next loan."

"They do not pay off their loans because they are constantly increasing them; but they devote the whole of their sinking funds to the reduction of their new loans."

The tramway accounts of the Corporation appear to be curiously involved, so far as the capital is concerned, with other departments; thus, instead of acting as they would do if dealing with a private company's undertaking, the Corporation debit street widenings or property pulled down for the tramway works to the Statute Labour Department, the tramway being looked upon, as Mr. Kay says, "as a sort of spoilt child of the Corporation, and having most extraordinary facilities granted to it."

In the case of private companies applying for powers, the extortionate demands of local authorities for contributions to street widenings and other facilities, either prohibit the construction altogether or add heavily to the capital account, but in Glasgow the case is different, for not only has land been bought up and cleared for the tramways, but the street improvements are charged to the Street Improvement Rate, and the surplus land is built upon as a municipal speculation.

The tramway accounts are therefore relieved of heavy capital expenditure; as Mr. Kay points out, in the case of a private company for constructing tramways near Motherwell, they have to pay very stiffly for anything they do in the way of altering property, whereas the Glasgow Corporation alter streets and debit the amount to the statute labour or streets department, and not only that, but they have power to affix their wires to every building without paying any recompense whatever.

Mr. Kay claims that as a matter of principle the tramway undertaking of corporations and companies should be dealt with on the same lines, otherwise the comparative results shown are not accurate.

The electric lighting undertaking of Glasgow has never paid as a trading venture. The lighting of the streets is, as Mr. Kay contends, a police matter; the Corporation supply the light, but it might as well be manufactured by a company. He emphasises the principle involved in the general question by saying, "Municipal trading becomes opposed to justice so soon as it burdens, or takes power to burden, one class of citizens in order to benefit another, no matter how poor or how rich either class may be," and he illustrates his point in the case of electricity supply by showing that the users of electric light in Glasgow form a very small percentage of the population.

The Corporation have always recognised in the electric lighting accounts the necessary provision for depreciation, but the result of the trading has not been sufficiently good to allow of the allocation of the funds for the purpose. As to the capital account, the funds are supplied under the general arrangements already referred to as to borrowing, sinking fund, &c., and upon this important point the witness deals also with the question of value of assets. He says that the tramway service is all put down as an asset of the common good fund amounting to £2,183,000, and he adds that the rates have never been relieved by the common good. The sinking fund is invested in the Corporation securities, and Mr. Kay considers it unsound finance to invest a reserve fund in your own business. He alleges that no provision has been made, or intended to be made, for repaying a loan of £1,100,000, in 1907, and upon the general question of the value of the assets of the Corporation, considers that lending money for undertakings of doubtful value, and probably not realisable, is not a course which bankers would follow.

The moral of this evidence is, that municipal trading is unsound, and that, in order to ascertain the actual results, it is necessary to have the accounts audited by local accountants, who are independent of corporation influence; that provision should be made to meet debt when it falls due, and if the reserve fund is invested in non-realisable assets, the probability is that if money is dearer it must be borrowed at a disadvantage to replace old debts.

A great deal of valuable evidence was taken bearing upon the question so often debated, as to whether the sinking fund provides for depreciation. Mr. Charles Henry Wilson—the Lord Mayor's auditor and chairman of the Parliamentary Committee of the Leeds Corporation—expressed the opinion that revenue must provide for keeping things in good going order; but a special reserve fund must be created for renewals and contingencies. He differs from Mr. Kay, with regard to investing the sinking fund in a corporation's own undertakings, which practice he considers perfectly sound, but with the important qualification, "with the safeguards imposed upon them," and he also points out, as the way to pay loans when they fell due, that there would be no difficulty if stock is issued falling due in 1927, to issue fresh stock to replace it gradually! This is like a man discharging a liability by accepting a bill and congratulating himself upon being now out of debt. Apply this to the well-worked argument that the sinking fund repays the cost of the electrical undertaking at the end of its equated life, providing for the depreciation as well, and no wonder that Lord Rothschild pressed the witness on the point and led him to reply: "I would have a special reserve fund to provide for these contingencies. I think that is an absolute necessity, otherwise a corporation might find itself some fine morning in a very serious corner."

With regard to the charge for street improvements in connection with tramway undertakings, Mr. Wilson considers it perfectly right that a company should be penalised by having to pay for the widening of the streets and pulling down of houses, but admits that the Corporation of Leeds debit such costs to the Consolidated Fund. And yet municipal traders compare the trading results of local authorities and private companies, claiming that the wicked monopolists cannot do so well as the virtuous Socialists!

(*To be concluded.*)

RECENT STEAM TURBINE DEVELOPMENTS.*

By W. L. R. EMMET.

When the writer agreed some months ago to present a paper to this meeting, he fully expected that its subject-matter would mainly consist in a record of practical results accomplished with commercially operating machines, and that such matter would be full enough to justify its presentation and discussion. Some months ago a paper was presented to the American Philosophical Society on this same subject which has since gone the rounds of the Press. This paper dealt at some length with our expectations concerning the new steam turbine developments now going on at Schenectady, but gave no actual results other than those produced by a single 600-KW. machine which has been operating for some time at Schenectady, and which is different in many respects from the machines now being built.

The scant array of established facts in this paper and the rather liberal presentment of expectations have called forth some criticism, particularly from European turbine builders. Such criticisms are not unnatural under the circumstances, and we are naturally eager to demonstrate to the world the soundness of the claims upon which the General Electric Co. and its customers have based such large undertakings.

The writer had confidently expected that before this date the 5,000-KW. turbine recently installed at Chicago would have been fully tested and verified, and that its results could be here presented to the members of this Association, who are so deeply interested in the success of developments of this kind. We have fallen a little short of this expectation through such unforeseen delays as are usual in such cases, but still have produced results which are highly interesting and suggestive, although no complete tests have yet been made. The machine has been installed in the new station of the Commonwealth Electric Co., which is probably the finest and best-equipped station in the world, and has been connected to its regular equipment of boilers and condensing facilities. It has been started without any hitch or delay, and has been operated repeatedly at full load and under a variety of conditions to test its performance. It has operated with a wonderful steadiness and perfection, has governed perfectly from full load to no load with only 2 per cent. speed variation, and has in every respect shown itself to be a thoroughly desirable operating machine. A test of steam economy was also very carefully conducted on this machine, very perfect facilities for weighing water and maintaining a steady and accurately measured load having been provided. Unfortunately, the results of these tests were found afterwards to be entirely indefinite since a large leakage of circulating water, through a misplaced valve, into the steam space of the condenser was discovered, which water had been weighed in connection with the condensed steam. When this was discovered it was too late to ascertain with certainty the amount of this leakage at the time of test. The flow with no load, however, indicated that this leakage was very large, and the general inference drawn from our test is that a very fine steam economy was shown. We will, however, refrain from making any positive statements on this subject until we have obtained tests which are absolutely unquestionable.

* A paper read at the Saratoga meeting of the American Street Railway Association.

All the conditions in connection with the running of this machine have given very favourable indications. The machine is connected so that the condensed water passes from the hot well through a heater and is pumped directly back into the boiler. This whole system was in operation and worked perfectly. The water returned to boilers was, of course, entirely free from oil and quite clear except at light load, when the leakage from river water appreciably discoloured it. The plant operated at full load with four 500-H.P. boilers fired out of the eight which have been provided for each machine. These boilers were fired with Illinois coal on chain grates, and their performance of the work is in itself an indication of good economy.

After this test run the machine was taken apart for the purpose of making a minor internal change which was thought to be desirable. The machine will not be required for service for some months, and our desire is to get it in the best possible condition in advance of the time when it will be required to carry a large winter load. The machine will probably be ready to run again within about a week or 10 days, and conclusive tests will then be made.

In order to properly understand the significance of the successful starting of this machine, it is necessary to review the history of its design and to compare it with engines of other types. After the experiments with Mr. Curtis's steam turbine inventions had proceeded for several years, certain experimental results were obtained which seemed to justify the production of commercial machines, and it was decided to build a commercial machine for use in the Schenectady works. A 600-KW. machine with horizontal shaft was designed, the mechanical arrangements being in most respects in accordance with the plans which Mr. Curtis had formed previous to that time for building the turbines. This machine was built and tested nearly two years ago.

These tests showed a high steam economy, and it was very soon decided that the performance of this machine justified the building of other commercial machines which could safely be relied upon to perform as good or better results. The question of mechanical design for these larger machines then became a matter of first importance. The steam economy could safely be expected to conform closely to that of the machine which had already been tested, but the whole question of cost and commercial desirability depended upon the mechanical construction adopted for accomplishing the desired results.

It was decided, at this time, to build a steam turbine unit as large as the largest engine-driven generating unit in the country, and as the result of this decision the design of the machine now in Chicago was made up after a great amount of thought and study. This design embodied many very radical features as compared with other engines, turbines or machines, of any character. The shaft is vertical; the whole weight of the revolving part is borne by an oil film delivered by a presure pump to the lower bearing; the delivery of steam to turbine is controlled through a system of electrically operated individual valves worked by a small controller something after the manner of the multiple unit train control system—a centrifugal governor moving the controller. The revolving field is mounted upon the same shaft with the turbine wheels, and the stationary portion of the generator is supported by the stationary portion of the turbine, the whole building up into the general form of a vertical cylinder about 25 ft. high and about 14 ft. in diameter. The total weight of the turbine and generator is 400,000 lbs. and its capacity is 5,000 KW. at full load. It is capable of running at about 75 per cent. overload condensing, and at nearly full-load non-condensing.

The question as to why the vertical shaft design was adopted for this unit has often been raised, and many doubts and criticisms concerning it have been expressed. It is not easy to explain all the reasons which led up to its adoption, but it may be said that the compactness and simplicity of this unit, which are its most marked characteristics, are largely due to the merits of this design. With the vertical shaft arrangement all lateral strain is removed from the bearings which align the shaft, and all deflection of the shaft is avoided with a minimum number and length of bearings. This matter of properly supporting a shaft and keeping it exactly central and in perfect alignment is an important one where small clearances are desirable with a large diameter in the revolving part. To carry such weights as are necessary in the revolving part of this large unit many very large bearings would be required if the shaft was in a horizontal position. An elaborate system of forced lubrication with artificial cooling would be necessary in connection with these bearings, and a failure of any of these bearings would occasion serious danger to the operation of the machine. If the machine were built in a horizontal position it would be very difficult to so support the wheels that their clearances would not be affected by sagging of the shaft or looseness in bearings, and also it might be difficult to place them with such a relation to each other that the clearance would not be affected by expansion of the shaft. In the vertical design the space between wheels is reduced to a minimum, the supporting structure is perfectly symmetrical, and cannot be in any way distorted or put out of line either by mechanical or steam pressure strains or by the effects of expansion.

The oil pressure step bearing at the foot of shaft supports the whole revolving element in a balanced position by perfectly symmetrical suspension and preserves the exact relation of level between the stationary and revolving parts. As long as this step bearing fills its functions a multitude of mechanical difficulties and uncertainties are overcome.

At the time this design was adopted there was no good precedent for the support in this manner of such a weight operating at so high a speed, and there were many predictions of failure, examples being quoted where similar methods had failed with water wheels and other machines. It seemed clear, however, that with proper arrangements the operation of this bearing must be stable and reliable, and since forced lubrication was necessary to success in any case, it seemed advisable to put it where it would accomplish the greatest number of good results.

Experience with a number of machines has fully justified our decisions in this connection. The bearings have run perfectly with an inappreciable amount of friction, and when properly supplied with oil operate with perfect steadiness and regularity. In one respect these bearings have agreeably surprised us; that is, they have been much less injured by stoppages of oil than we expected. In the course of our experiments imperfect pumping arrangements have been used and repeated failures of the oil flow have been experienced, but in no case has any damage to the machine resulted. Even the cast-iron blocks which constitute the step bearing are, as a rule, not destroyed. Our experience has been that they cut and heat when the oil supply is removed, but in all cases the surfaces have ground themselves to an operating condition after the oil flow is renewed, so that the machine could be continued in operation. This might not always be the case, but it seems quite certain that the damage could never be as serious as that which would result from a failure of the lubrication system where heavy weights are carried on high-speed horizontal bearings.

(To be continued.)

A CONTINENTAL COLLIERY INSTALLATION.

A couple of years ago the directors of the Gneisenau Colliery, Westphalia, installed an electric pumping plant, which was constructed and erected by the Helios Elektricitäts Actiengesellschaft, of Cologne, Ehrenfeld.

Up to that time there had only been a small electric plant for lighting purposes. To this was then added a larger plant for both lighting and power. Three-phase current was considered to be the most suitable, as the motor driving the pump would consume one-third of the total output, the output of this motor being 665 B.H.P. (head of water, 1,260 ft.).

The pressure of the three-phase generators is 2,500 volts at 1,500 periodicity. For lighting and power transmission on the surface, the pressure is transformed from 2,500 to 500 volts.

There are two 625-KW. steam dynamos; two sets of motor-generators for excitation and lighting purposes with continuous current, the output being 50 KW. and 38 KW. respectively; one 38-KW. 500-volt continuous current steam dynamo [this set was taken over from the old plant, and is now used for the excitation of the alternating current generators when starting]; several motors for driving machines in the different workshops; a complete switchboard, and, as already mentioned, one asynchronous motor of 665 B.H.P. for driving the main water pump.

The steam engines were constructed by the Sächsische Maschinenfabrik, in Chemnitz. They are compound engines of the horizontal type, the output being 680 B.H.P. each when running at 83 revolutions per minute. The generators are of the rotary field type, and the magnet coils are screwed to the rim of the fly-wheel by strong bolts.

The machines have 36 poles; there are 423 slots in the stator and three conductors in each slot.

The exciting current for both generators is supplied by two sets, each consisting of one three-phase motor directly coupled to a continuous current generator of 50 and 38 KW. respectively. The machines are coupled together by means of a Zodel-Voith flexible coupling. When starting, the main dynamos are excited by the 38-KW. continuous current generator mentioned above, thereby obviating the necessity of a storage battery.

The mining pump is double-acting, and consists of two separate cylinders driven by a common crankshaft. The cranks are at right angles to one another; the shaft is driven by the motor direct coupled to it. There are two air vessels on the suction and four on the delivery. The diameter of the cylinders is 216 mm., and the stroke is 600 mm. The piston rods are supported by the stuffing boxes. Lubricators are fitted for continuously oiling the piston rods.

The position of the pump is 380 metres (1,260 ft.) below the surface. The capacity of the pump is 152 cb. ft. per minute when running at full speed.

The motor, which, as before stated, is directly coupled to the crankshaft of the pump, is as follows:—Diameter of rotor, 3,600 mm.; width of field magnet poles, 610 mm. The speed is 61 revolutions per minute. There are 575 slots in the rotor, with two conductors in each slot; the stator has 432 slots with 16 conductors per slot.

This motor may be started either by one dynamo alone or from the main circuit. For the latter purpose slip-rings and short-circuiting gear as well as brush-lifting gear and a starter with oil bath are provided. Great difficulties in designing and erecting the stator were involved by the small area of the mine shaft, which is only 1,800 × 800 mm. It was necessary to build up the stator in four parts, and the rotor in two parts. The feet supporting the stator were fixed thereto with screws and bolts. The winding for both the stator and rotor had to be done in position, and great care was necessary owing to the damp atmosphere in the surroundings. The cast-iron frame is built up in four parts, and is provided with numerous holes for ventilation.

The short-circuiting gear consists of the following parts:—

Adjacent to the brushes there is a circular disc supporting suitable contact pieces on its periphery. The rotor conductors

are connected to these contacts so that the winding may be short-circuited by means of a metal ring operated by a lever. There is a second lever for lifting brushes when the motor has attained full speed. Both levers are interlocked, thereby avoiding the possibility of a wrong operation. The pump motor may also be started by connecting it to one of the generators when at rest, and then running the generator up to full speed; the motor, of course, synchronising, will be brought to full speed simultaneously. This is very simple and effective, no slip-rings being required; but when stopping the motor, it is necessary to first stop the generator, and this is the reason why two separate circuits are provided on the switchboard—*i.e.*, one for supplying the lighting and small motors only, the other for starting and supplying the pump motor. For starting the motor from the main circuit a starter with oil-bath is provided. Its resistances are inserted in the rotor circuit when starting the motor. The contact pieces of this starter are mounted on the periphery of a spindle, which receives the current by means of stationary brushes against which it revolves. The contact pieces are at such distance one from another as to ensure sufficient insulation; the resistance material is German silver. When operating the starter the resistances are moved in the old bath, which is cooled by water circulating pipes, thereby securing great safety in working; the starter is comparatively small, as the motor is always started at no-load, and runs for one or two days continuously.

The following figures which have been forwarded to us show the results of the tests taken on December 4th, 1902, when running the motor in conjunction with a separate generator:—

Output of the steam engine 643·45 B.H.P.
Output of the pump 442 "
Combined efficiency of plant $\frac{442 \times 100}{643\cdot45} = 68\cdot6$ per cent.

As the draining plant was originally designed for 450 m. head of water, the figures show that during the test neither the motor nor the engine was running at full load, the latter having a normal output of 800 B.H.P. When running at full load the power factor of the motor, and also the efficiency of the steam engine, should be far better.

But even under the above-mentioned circumstances the total output of the whole plant is much higher than that of a steam-driven pump, and it has also many other obvious advantages.

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

19,200. "An automatic life guard to be applied to electric tramcars." H. LAMBELLE. September 7th. (Complete.)

19,207. "Improvement in apparatus for igniting fuses for blasting purposes and the like." G. TOUCHER. September 7th.

19,249. "Electric controlling apparatus." C. E. SCHÖNFELDER. September 7th.

19,250. "Improvements in telephone receiver holders." A. J. BRIGGS. September 7th. (Date applied for under Patents Act, 1901, September 6th, 1902, being date of application in United States.) (Complete.)

19,251. "Improvements relating to electric telegraphy." S. G. BROWN. September 7th.

19,291. "Improvements in the electric extraction of sodium, potassium and the alkaline metals." E. T. PARKER. September 8th.

19,319. "A cell recorder for use in electric light stations and other places." A. J. ABRAHAM. September 8th.

19,341. "A new or improved apparatus for use in laying pipes for sewers, drains, electric light, gas, water mains, and such like." R. T. HAYES. September 8th.

19,363. "Improvements in or relating to electric insulated cables." H. R. GARRARD. September 8th.

19,367. "An improvement in the insulation of electric conductors." E. L. PINCHING and W. H. WALTON. September 8th.

19,368. "An improvement in the electro-deposition of copper." H. PARKES. September 8th.

19,399. "Improvements in pipe sockets or couplings, more especially for the purpose of facilitating inspection when used with pipes which contain electric wiring." E. WHITE and J. WALDRON. September 9th. (Complete.)

19,419. "Improvements in high frequency electrical appliances." L. B. MILLER. September 9th.

19,427. "An improved mechanical electrical switch for use on tramways and light railways, worked on a surface contact system." J. P. TRUMBLE and T. M. TRUMBLE. September 9th.

19,487. "Improvements in raising and lowering electric arc lamps." W. A. BROWN. September 9th.

19,454. "Operating vapour electric lamps from an alternating current source." E. WEINTRAUB. (Date applied for under Patents Act, 1901, October 18th, 1902, being date of application in United States.) September 9th. (Complete.)

19,491. "Improvements in and relating to arc lamps." C. E. FOSTER, E. R. GROTE and M. V. ELY. September 10th.

19,513. "Improvements in and relating to underground current conductors, and surface rail contacts for electric street railways." A. KUCHINSKA. September 10th.

19,514. "Improvements in drum switches for electric vehicles." P. REITZ. September 10th.

19,520. "Improvements in alternating current electrical apparatus." C. F. SCOTT. (Date applied for under Patents Act, 1901, September 18th, 1902, being date of application in United States.) September 10th. (Complete.)

19,521. "Improvements in systems of alternating current distribution for railways." C. F. SCOTT. (Date applied for under Patents Act, 1901, September 18th, 1902, being date of application in United States.) September 10th. (Complete.)

19,553. "Improvements in and relating to printing telegraph apparatus." H. CASEVITZ. (Date applied for under Patents Act, 1901, September 11th, 1902, being date of application in France.) September 10th. (Complete.)

19,633. "Improvements in apparatus suitable for detecting electric, Hertzian, or similar waves or currents." J. R. FOTHERGILL and H. FOTHERGILL. September 11th.

19,657. "Improvements in and relating to the working of points and plough guides on electric or cable tramways or railways." W. J. STEWART. September 12th.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1902.

10,466. "Electrical appliance for working pile drivers." J. Garvie. Dated May 7th.

11,725. "Improvements in or relating to metallic conduits and fittings for electric cables and the like." L. M. Waterhouse and Simplex Steel Conduit Co., Ltd. Dated May 23rd.

11,765. "A method of measuring temperature at a distance by electrical means." C. W. S. Crawley and A. P. Trotter. Dated May 23rd.

11,823. "Improvements in and relating to regenerative apparatus for electric railways and similar purposes." H. H. Lake. (General Electric Co.) Dated May 24th.

11,842. "Improvements in electric meters." H. H. Lake. (General Electric Co.) Dated May 24th.

11,845. "Improvements in electric plug fuses." H. H. Lake. (General Electric Co.) Dated May 24th.

12,078. "Improvements in electric transformers." H. H. Lake. (General Electric Co.) Dated May 27th.

12,182. "Improved manufacture of electrical glow lamps with osmium filaments." O. Imray. (Oesterreichische Gasgluhlicht-und Electricitäts Gesellschaft.) Dated May 28th.

12,241. "Improvements in or relating to electric arc lamps." H. Bremer. Dated May 29th.

12,284. "Improvements in arc light projecting apparatus applicable for illuminating fountains." A. Engelsmann. Dated May 29th.

12,291. "Improvements relating to electric switches." H. H. Lake. (General Electric Co.) Dated May 29th.

12,294. "Improvements in dynamo-electric machinery." H. H. Lake. (General Electric Co.) Dated May 29th.

12,415. "Improvements in regulators for alternating electric current circuits." British Thomson-Houston Co., Ltd. (C. P. Steinmetz.) Dated May 31st.

12,416. "Improvements in tubulating machines for incandescent electric lamps." British Thomson-Houston Co., Ltd. (W. R. Burrows.) Dated May 31st.

12,449. "Improvements in means for registering or metering electrical energy to be charged for under varying conditions of supply." L. J. Aron. Dated May 31st.

12,469. "Improvements relating to electrical indicating and recording instruments." E. Weston and A. O. Benecke. Dated May 31st.

12,494. "An improved safety guard for electric tramcars and the like or similarly propelled vehicles." R. S. Burn. Dated June 2nd.

12,684. "Improvements in preventing leakage of current to studs in surface contact systems of electric traction." W. G. Griffiths and B. H. Bedell. Dated June 3rd.

12,823. "Improvements in electrical measuring instruments." A. C. Heap and W. O. Smith. Dated June 5th.

13,308. "Improvements in or appertaining to life guards for electric tramcars and the like." D. Newton. Dated June 12th.

13,529. "Improvements in electric switches and cut-outs." British Thomson-Houston Co., Ltd. (C. E. Harthan.) Dated June 14th.

13,572. "A new or improved electrically-operated hammer." H. B. Stock and C. Mc. de Bingham. Dated June 16th.

13,737. "Improvements relating to systems for electrical distribution." H. H. Lake. (General Electric Co.) Dated June 17th.

13,742. "Improvements in systems of electrical distribution." H. H. Lake. (General Electric Co.) Dated June 17th.

13,851. "Improvements in electric motor controllers." British Thomson-Houston Co., Ltd. (J. B. Sinn.) Dated June 18th.

13,852. "Improvements in electric switches or circuit breakers." British Thomson-Houston Co., Ltd. (R. H. Read.) Dated June 18th.

14,001. "Improvements in electro-magnetic brakes." J. G. Childs. Dated June 20th.

14,135. "Improvements in electrolytic cells." H. Baker, A. T. Smith and Castner-Kellner Alkali Co., Ltd. Dated June 21st.

14,542. "An improved coupling for electric lamps and the like." E. R. Gill. Dated June 20th.

14,605. "Improvements in starting switches for electric lifts." Easton and Co., Ltd., P. I. Unwin and J. Björnstad. Dated June 30th.

14,767. "Improvements in or relating to portable and other electric lamps and switches therefor." E. R. Gill. Dated July 2nd.

14,768. "Improvements in or relating to portable electric lights." E. R. Gill. Dated July 2nd.

14,851. "Improvements in or relating to electric vehicles." L. Lohner and F. Porsche. Dated July 3rd.

14,869. "Improvements relating to electric arc lamps." H. H. Lake. (H. Cuenod.) Dated July 3rd.

14,897. "An improvement in 'frogs' or points for overhead wire systems of electric traction." W. Harris, H. Brecknel, E. M. Munro and H. I. Rogers. Dated July 4th.

14,899. "Improvements in connection with the safety fuses for electric circuits." E. Schattner. Dated July 4th.

14,962. "Improvements in conduits for electric cables." A. Wakefield. Dated July 4th.

15,128. "Improvements in apparatus for electrolytically coating sheet metal with zinc." A. G. Bloxam. ("Columbus" Electricitäts Gesellschaft m.b.H., Germany.) Dated July 7th.

15,346. "Improvements in magnetic clutches." H. H. Lake. (General Electric Co.) Dated July 9th.

15,350. "Improvements in arc lamps." W. P. Thompson. (C. J. Toerring. Dated July 9th.

16,906. "Improvements in electric circuit breakers." H. H. Lake. (General Electric Co.) Dated July 30th.

16,923. "Improvements relating to the manufacture of incandescent electric lamps." H. H. Lake. (General Electric Co.) Dated July 30th.

17,111. "A new receiver for wireless telegraphy." L. H. Walter. Dated August 2nd.

17,460. "An improved regulating lever and instantaneous brake applicable to machines driven by electric motors." Bradbury & Co., Ltd., and W. C. Drybrough. Dated August 8th.

17,611. "Improvements in electric checks." C. J. Moberg. Dated August 11th.

17,633. "Improvements in the method of and means for securing shades, reflectors or the like used in connection with incandescent electric lamps." A. Morrison and J. W. Butterworth. Dated August 12th.

17,678. "Improvements in or relating to electric lamp globes." R. Böhm and E. Böhm. Dated August 12th.

17,690. "Improvements in electric arc lamps." H. H. Lake. (General Electric Co.) Dated August 13th.

17,841. "Improvements in methods of and means for producing, shaping and employing electric current pulses." F. H. Loring. Dated August 14th.

18,008. "Improvements in the electrical ignition apparatus of internal combustion engines." Tangyes, Ltd., and J. Robson. Dated August 15th.